1.0 GENERAL

1.1 Project Description

The Project generally consists of adding two tolled express lanes westbound from I-25 to Colorado Boulevard; one tolled express lane westbound from Colorado Boulevard to Wadsworth Boulevard; one tolled express lane eastbound from just west of the Platte River to I-25; safety and operational improvements between I-25 and Quebec Street via adding direct-connect ramps from I-25 to the C-470 tolled express lanes; full reconstruction of a portion of the existing pavement; adding auxiliary lanes at select locations; improving portions of on-ramps and off-ramps to current standards (including ramp metering where appropriate); realigning substandard curves; widening existing structures throughout the corridor; replacing the bridges over the South Platte River; installing water-quality features where required; installing noise barriers where required; adding grade separations for the multi-use trail at Quebec Street and Colorado Boulevard; and installing tolling/Intelligent Transportation Systems (ITS) elements.

1.2 Project Goals

The following Project Goals and objectives have been established for the execution of the Project:

1. Optimize traffic operations on C-470 within the project budget.

    a. Once operational, optimize trip reliability in the tolled express lanes by maintaining a 45 mph minimum operating speed.

    b. Preserve the existing general purpose lanes by providing improvements that enable them to operate at levels better than the no-action condition.

2. Optimize scope of improvements within the project budget.

3. Optimize operating and life-cycle maintenance costs.

4. Minimize impacts to the traveling public during project construction and future construction.

5. Achieve the following project schedule milestone.

    a. Expenditure of $100M RAMP funding by December 31, 2017.

    b. Work Cooperatively with the E-470 Public Highway Authority on the planning, installation, and testing of tolling infrastructure; culminating in the Tolling Final System Wide Acceptance Test to facilitate Express Lane Toll Collection as early as possible.

1.3 Environmental Compliance

The Federal Highway Administration signed a revised Environmental Assessment on July 24, 2015 for ultimate improvements to the C-470 Corridor between I-25 and Kipling Parkway. The public review and comment period for the revised Environmental Assessment will conclude September 11, 2015. Following the public review and comment period, CDOT and FHWA will prepare a Decision Document. If the Decision Document results in a Finding of No Significant Impact, the Federal Highway Administration will sign the Finding of No Significant Impact and the Project will be subject to environmental commitments and mitigation documented in the revised Environmental Assessment and Finding of No Significant Impact.

This Project and Work is provided for under the NEPA and as such shall not preclude anything required as part of the revised Environmental Assessment. Mitigation measures needed in response to Project impacts shall be implemented with the Work. No Project mitigation measure resultant of the Work shall be deferred to a future project.

1.4 Basic Configuration

The following describes the Basic Configuration for the Project:

The Basic Configuration is generally defined as Work within the existing or new Right-of-Way that is required to construct the following:

1. Pavement and Lanes

    a. Reconstruct and/or overlay all C-470 mainline and C-470 ramp pavement in Portland Cement Concrete Pavement (PCCP).

    b. Reconstruct C-470 mainline between I-25 and Wadsworth Boulevard to conform to the lanes shown in Exhibit A – Basic Configuration and Exhibit B – Typical Sections. Westbound C-470 limits shall begin at a point west of the westbound off-ramp physical gore to Wadsworth Boulevard at which horizontal and vertical tie-in is obtained and end at the western edge of southbound I-25. 2” Mill and Overlay is required for WB from the eastern approach slab of the westbound C-470 Bridge over Wadsworth Boulevard to the western limits of westbound reconstruction. Eastbound C-470 limits shall begin at a point 4,000 feet west of the Platte River and end at the western edge of southbound I-25.

    c. Reconstruct existing ramps and construct new ramps at the C-470 / I-25 Interchange to conform to the lanes shown in Exhibit A – Basic Configuration and Exhibit B – Typical Sections to provide a direct connect ramp from southbound I-25 to the westbound C-470 express lanes; a direct connect ramp from northbound I-25 to the westbound C-470 express lanes; a direct connect ramp from westbound E-470 to the westbound C-470 general purpose lanes.

d. Reconstruct existing ramps at all service interchanges to conform to the lanes shown in Exhibit A – Basic Configuration and Exhibit B – Typical Sections, to a point on the ramp where geometric tie-in is achieved. The limits of reconstructed ramp shall also be to a point where pavement type on the remainder of existing ramp, not reconstructed, is consistent with the pavement type of the cross road. Service interchanges include:

   i. Wadsworth Boulevard (Westbound off-ramp)

   ii. Platte Canyon

   iii. US 85 (Santa Fe)

   iv. Lucent Boulevard

   v. Broadway

   vi. University

   vii. Quebec Street

   viii. Yosemite Street

e. Construct all tie-ins to existing C-470 typical section with existing pavement type. Construct all tie-ins to existing ramps with PCCP.

f. Reconstruct the raised medians and turn lanes at service interchanges where widening of C-470 mainline bridges conflict with existing raised medians and turn lanes. Service interchange cross road pavements shall match existing pavement for pavement type and pavement section depth.

2. Bridges

a. Construct new bridges at the C-470/I-25 Interchange to incorporate the direct connect ramps to conform to the lanes shown in Exhibit A – Basic Configuration and Exhibit B – Typical Sections.

b. Reconstruct the C-470 mainline bridges over the South Platte River to conform to the lanes shown in Exhibit A – Basic Configuration and Exhibit B – Typical Sections.

c. Widen existing C-470 mainline bridges to conform to the ultimate lanes and shoulders as shown in the bridge typical sections in the reference plans:

   i. C-470 over Yosemite

   ii. C-470 over Acres Green Drive

iii. C-470 over Big Dry Creek

iv. C-470 over University

v. C-470 over Broadway

vi. C-470 over Erickson Boulevard

3. C-470 Trail

   a. Reconstruct the C-470 Trail where widening of C-470 mainline, relocation of ramps, and new ramps conflict with the existing trail.

   b. Construct trail grade separation at Quebec as shown in Exhibit A – Basic Configuration to include the following:

      i. Full trail grade separation under the westbound off-ramp and westbound on-ramp

      ii. Full trail grade separation under Quebec Street

      iii. Local street connection to Quebec Street east and west of Quebec Street.

   c. Construct trail grade separation at Colorado as shown in Exhibit A – Basic Configuration to include the following:

      i. Full trail grade separation under Colorado

      ii. Local street connection to Colorado east and west of Colorado

      iii. Local connects to existing neighborhoods as they exist prior to construction

4. Drainage and Water Quality:

   a. Provide drainage improvements as is necessary to complete the work.

   b. Provide permanent water quality improvement as is necessary to complete the work according to local agency agreements.

5. Alignments:

   a. The horizontal alignments, as shown in the Reference Drawings, may be changed up to 20 feet.

   b. The vertical alignment, as shown in the Reference Drawings, may be changed up to 5 feet.

Reference Documents are provided solely for Contractors reference and are without representation or warranty by CDOT, except to the extent incorporated by the Basic Configuration description set forth in this Section, and in the Contract Documents (excluding the Proposal Documents). Regardless of the level of completion or suitability of any portion of Reference Documents, the Contractor shall be solely responsible for Project design and CDOT shall have no liability or obligation as a result of design work contained in Book 5 – Reference Documents.

1.5 Additional Requested Elements (AREs)

The following Additional Requested Elements (AREs) are identified as elements of the Project that may be incorporated into the Basic Configuration as a part of the Contractor's Proposal. The AREs are graphically shown on Exhibit C - Additional Requested Elements.

1.5.1 ARE Descriptions

1. ARE 1 – Construct eastbound Express Lane to Wadsworth

   All the additional Work necessary to extend the beginning of the eastbound express lane entrance to the Wadsworth eastbound on-ramp that fully conforms to the C-470 lane and shoulder configuration as shown on Exhibit B – Typical Sections. Additional work shall include 2" Mill and Overlay from the eastern approach slab of the eastbound C-470 Bridge over Wadsworth Boulevard to the westerly limit of full reconstruction.

The Contractor shall be responsible for assessing the environmental clearance requirements of the AREs. In addition, the Contractor shall be responsible for additional environmental documentation, permits, and mitigation resulting from impacts associated with AREs, except as is otherwise provided for in the Contract Documents. The Contractor shall also be responsible for assessing Right-of-Way issues, hazardous materials, permanent water quality, utility conflicts, third party agreements, and any other additional permits or requirements to design and construct the AREs. AREs shall conform to all other requirements of the Contract Documents.

1.5 Exhibits

Exhibit A: Basic Configuration

Exhibit B: Typical Sections

Exhibit C: Additional Requested Elements

Exhibit C-1: ARE 1

Exhibit D: Ultimate Configuration

2.0 PROJECT MANAGEMENT

2.1 Administration

The Contractor has the responsibility for management and performance of the Work. CDOT shall have the right to visit the Site and observe the Work to determine that the Work is proceeding in conformance with the requirements of the Contract Documents.

2.1.1 Work Breakdown Structure (WBS)

The Contractor shall submit to CDOT, along with its Preliminary Baseline Schedule, a detailed Work Breakdown Structure (WBS) for Acceptance. The Preliminary Baseline Schedule shall include a detailed, organized hierarchical division of the (WBS) for completing each element of the Work. The Accepted WBS shall be the basis for organizing all Work under the Contract Documents, and shall be used as a basis for the Contract Schedules, and other cost control systems. The Contractor shall refer to and utilize Exhibit A of Book 2, Section 2 – Project Management for preparation of the WBS. The WBS shall conform to Exhibit A, Section 2-Project Management. Exhibit A of Book 2, Section 2 – Project Management graphically depicts the WBS Activities.

All cost and schedule information shall roll up to Level I through VI as identified in the Exhibit A. Further detail shall be provided by the Contractor for Level VI (e.g. individual Structures) to ensure a clear understanding of the Contract. The Contractor shall submit its Preliminary Baseline Schedule broken down to the WBS Level VI.

The Accepted WBS shall be the basis for organizing all Work under the Contract, and shall be used to structure the Contract Schedules, and other cost control systems. The Contractor shall submit its Preliminary Baseline Schedule specifying WBS Activities and proposed Work segments prior to NTP1. NTP2 shall not be issued until CDOT has Approved the Original Baseline Schedule.

A methods statement shall be prepared for each of the Level VI WBS Activities listed in the Original Baseline Schedule for all critical path items, and for any Activity not listed that the Contractor considers a controlling factor for timely completion. The methods statement shall be completed in accordance with the *Standard Specifications*.

Table 2.1
WBS LEVELS

Level I:	**DESIGN-BUILD PROGRAM**
Program Level – CDOT use only: The summary of all Design-Build Contract components	
Level II:	**MAJOR PROGRAM ELEMENTS**
Major Program Elements: ❑ Activities of the Contractor. This is the Contractor's highest level. * Basis for Price Proposal to be submitted as identified on Form J	
Level III:	**CONTRACT COMPONENTS**
Design-Build Contract Components: ❑ Breakdown of all subcomponents as shown on Exhibit A of this section. * Basis for Price Proposal to be submitted as identified on Form J	
Level IV:	**CONTRACT SUBCOMPONENTS**
Design-Build Contract Subcomponents: ❑ Breakdown of all major subcomponents of the Contract as shown on Exhibit A ❑ The Contractor to define certain Activities at this level (work areas) ❑ See Exhibit A for Contract specified Level IV Activities and other detail ❑ AREs * * Basis for Price Proposal to be submitted as identified on Form J	
Level V:	**CONTRACT SUBCOMPONENTS AND WORK ACTIVITIES**
Breakdown of the Contract Sub-components and Work Activities defined by the Contractor: ❑ Minor subcomponents (by Phase, etc.) ❑ Contractor to define certain activities at this level (work areas, phases, etc.) ❑ See Exhibit A for Contract specified Level V Activities and other ❑ Basis for all progress payments	
Schedules – The following CPM Schedules shall be cost loaded to this level: ❑ Preliminary Baseline Schedule ❑ Original Baseline Schedule (or Revised Baseline Schedule, if applicable) ❑ Current Baseline Schedule ❑ Monthly Progress Schedule ❑ Recovery Schedule ❑ As-Built Schedule	

Level VI:	WORK SUB-ACTIVITIES
Breakdown defined by the Contractor: ❑ The Contractor to define all Activities at this level	
Schedules - No specific Contract Schedules are required at this level. However, Level VI Activities are required as a component of the Monthly Progress Schedule.	

The payment to the Contractor will be in the amount shown on the Contractor's Approved invoice less Retainage and any deductions.

2.1.2 Cost Management

2.1.2.1 Progress Payment Calculations

CDOT will base progress payments on a mutually agreed estimate of percent complete of the Work, not on measured quantities. The Contractor shall progress the Activities identified on the Approved Original Baseline Schedule, the Current Baseline Schedule or the Approved Revised Baseline Schedule (if applicable), for determining the Monthly Progress Schedule. The Accepted Monthly Progress Schedule will determine the amount of the Contractor's progress payments. Percent complete shall be calculated using project scheduling software meeting the requirements of this section, where progress is measured based on percent complete/Days remaining.

Partial payment for stored Materials shall only be made as allowed in the Contract. The Contractor's invoice shall not include a request for payment for Nonconforming Work documented by the Contractor's Quality Manager or CDOT. The payment to the Contractor will be in the amount shown on the Contractor's Approved invoice less retainage and any deductions.

2.1.2.2 Invoice Submittals

The Contractor shall submit invoices to CDOT each month. Each monthly invoice shall be submitted in draft form for review within 10 Working Days following prior month's end. Draft invoice submittals shall be done electronically in Microsoft Excel format.

The Contractor shall submit to CDOT for Approval each final monthly invoice in accordance with Section 2.1.2.4. Final invoice submittals shall be done electronically in Microsoft Excel format.

2.1.2.3 Invoice Document Content

The requirements for the supporting documents to be included with the invoice form shall be finalized by the Contractor in consultation with CDOT and Approved by CDOT before NTP1. The Contractor may present variations in this format for CDOT Approval at least 15 Days prior to the submittal of the first invoice. Once the invoice format has been Approved by CDOT, the format shall not change unless subsequently Approved by CDOT.

The invoice documents shall include:

1. Invoice Cover Sheet

The Cover Sheet shall indicate the following information:

A. Project number and title

B. Invoice number (numbered consecutively starting with "1")

C. Period covered by the invoice (specific calendar dates)

D. Total earned to date for the Project as a whole and for each Level VI- WBS Activity

E. Nonconforming Work and amount withheld identified

F. Authorized signature and title of signatory

G. Date that invoice was signed

2. Monthly Progress Report

The Monthly Progress Report shall include the following:

A. Brief narrative description of Level VI- Activity and progress for the Project as a whole, including maintenance, design, and construction. Identify start date and completion dates

B. Update of progress with respect to Utilities (if any)

C. Identify whether any Completion and Final Acceptance Deadlines are achieved or revised during the period

D. Summary of ICQC/PC efforts, including result of design reviews

E. Identify problems/issues that arose during the period and remaining issues to be resolved

F. Summarize resolution of problems/issues raised in previous monthly progress reports or resolved during the period

G. Summary of non-conformance correction status

H. Summary of Project accidents (frequency and severity) and corrective actions taken

I. Identify critical Schedule issues and proposed resolution

J. Discuss Schedule variations from Completion Deadlines that have slipped or improved

K. Monthly DBE/WDP Report and tracking

L. Summary of Public Outreach during the period

M. Progress photographs

N. Three-month look-ahead schedule as further defined in Section 2.1

O. A Predecessor and Successor report that defines all schedule logic and clearly indicates all logical relationships and constraints shall be submitted with each CPM schedule submittal.

P. An Early Start report listing all activities, sorted by Actual/Early Start shall be submitted with each CPM schedule submittal

Q. A Total Float report listing all activities sorted in ascending order of total float shall be submitted with each CPM schedule submittal.

R. A No-work days report listing all legal Holidays and no work days that were accounted for in the preparation of the schedule shall be submitted with each CPM schedule submittal.

The format and detail level required for submittal of the monthly progress report shall be developed by the Contractor, in consultation with CDOT within 10 Working Days after NTP1. The Monthly Progress Report shall be on Contractor 8.5- x 11-inch letterhead.

3. Updated Monthly Progress Schedule

No invoice shall be Approved for payment made if there is not a current Accepted Monthly Progress Schedule and Current Baseline Schedule in place. The status date of the Monthly Progress Schedule, coinciding with the payment invoice date, is the last day of each month. The data date for use in calculating the Monthly Progress Schedule shall be the first Working Day of the following month.

The Contractor shall make all corrections to the Monthly Progress Schedule requested by CDOT and resubmit the Monthly Progress Schedule. If the Contractor does not agree with CDOT's comments, the Contractor shall provide written notice of disagreement within 5 Working Days from the receipt of the comments. The items in disagreement shall be resolved in a meeting held for that purpose, if necessary.

4. Certification by Contractor's Quality Manager

The Contractor shall submit a certification signed by its Quality Manager accompanying each invoice request certifying that:

A. All Contract Work, including that of designers, Subcontractors, Suppliers, and fabricators has been checked and/or inspected by the Contractor's Quality Program staff, and that all Work, except as specifically noted in the certification, conforms to the requirements of the Contract Documents.

B. The Quality Management Plan, and all of the measures and procedures provided therein, are functioning properly and are being followed.

C. All safety-critical Work, in conformance with the Project Safety Management Plan as further described in the Standard Specifications has been reviewed and sealed by the Professional Engineer of responsible charge before construction begins.

No invoice will be Approved (payment made) if there is not completion and implementation of the Quality Management Plan (QMP).

5. Monthly Maintenance Progress Report

   The Contractor shall submit to CDOT the current Monthly Maintenance Progress Report, as required in Book 2, Section 18.

   No invoice will be reviewed or processed until all invoice documents and certifications, as identified in 2.1.2.3 are received by CDOT.

2.1.2.4 Progress Status Meetings

A Progress Status Meeting shall be conducted three Working Days following draft Monthly Invoice submittals. The meeting shall be used to verify, address and finalize the following:

1. Actual start dates
2. Actual and planned Completion Deadlines
3. Earned value of Work that has been Accepted and reported in-place, based on installed quantities and Material on Hand (stockpiled Materials)
4. Activity percent complete
5. Incorporation of Approved Change Orders
6. Verification of unit-price items, if any
7. Status of outstanding Nonconforming Work
8. Completion of Value Engineering Change Proposals, if any
9. Work performance
10. Project Schedule, including changes from previous month's Schedule
11. Critical Path(s)

Following the progress status meeting, CDOT shall have up to 5 Working Days to review, verify, and comment on the draft invoice submittal. After reviewing, CDOT will return the draft for the Contractor to revise and correct. The Contractor shall then submit a corrected and final Monthly Invoice to CDOT for Approval. Approval of the final Monthly Invoice will be issued within 7 Working Days, contingent upon the Contractor's satisfactory resolution of CDOT's comments of the draft invoice submittal.

2.1.3 Schedule Management

2.1.3.1 General

The Work specified in this subsection includes preparing, progressing, revising, and submitting Contract Schedules.

The Contract Schedules shall represent a practical plan to complete the Work within the Completion Deadlines and convey the intent in the manner of the prosecution and progress of the Work.

The Contract Schedules shall include the planned execution of the Work in accordance with the Contract Documents. The Contract Schedules shall include involvement and coordination with other Contractors, Utility Owners, Governmental Persons, Engineers, Architects, Subcontractors, and Suppliers in the development of the Original Baseline Schedule, Revised Baseline Schedule, and updating of subsequent Monthly Progress Schedules.

All Contract Schedule submittals are subject to review, Acceptance and/or Approval by CDOT.

The Contract Schedules shall represent the requirements of the Contract Documents and the Work shall be executed in the sequence and duration indicated in the Contract Schedules.

All Contract Schedules shall be developed consistent with the Accepted WBS and the Completion Deadlines.

2.1.3.2 Contract Schedule and Term Definitions

Contract Schedules shall include the Preliminary Baseline Schedule, Original Baseline Schedule, Current Baseline Schedule, Revised Baseline Schedule, Monthly Progress Schedule, Recovery Schedule, and the As-Built Schedule.

2.1.3.2.1 Preliminary Baseline Schedule

The Preliminary Baseline Schedule is defined as the initial Project schedule for the purpose of initiating Work on the Project. It shall be a CPM schedule with Activities for the first six months following NTP1 and shall be cost-loaded to WBS Level VI. The Preliminary Baseline Schedule shall conform to the Accepted WBS and include all Contractor-defined WBS Level V and VI Activities.

2.1.3.2.2 Original Baseline Schedule

The Original Baseline Schedule is defined as the Contractor's original plan for the Project from NTP1 through Final Acceptance. It shall be a detailed CPM Schedule with Work Activities and Completion Deadlines included for the full term of the Project. The Original Baseline Schedule shall be developed from the Preliminary Baseline Schedule and shall conform to the Accepted WBS and include all Contractor defined WBS Level VI Activities. The Original Baseline Schedule shall not change after Approval.

The Original Baseline Schedule shall be cost loaded to WBS Level VI and summarized for the aggregate costs equal to the WBS Level V prices set forth in the Proposal Documents.

2.1.3.2.3 Current Baseline Schedule

The Current Baseline Schedule is defined as the Original Baseline Schedule with cost and Schedule changes from Approved Change Orders incorporated. It shall be updated monthly with only Approved cost and Schedule changes. This Schedule will not show progress but shall maintain the original data date from the Original Baseline Schedule as a baseline. The Current Baseline Schedule shall be submitted to CDOT for Acceptance with each Monthly Invoice.

The Current Baseline Schedule shall be cost loaded to WBS Level VI and summarized for the aggregate costs equal to the WBS Level V prices set forth in the Proposal Documents as adjusted for Approved Change Orders.

2.1.3.2.4 Revised Baseline Schedule

The Revised Baseline Schedule is defined as the Contractor's plan for the Project which is current with progress to date. This Schedule shall reflect the planned execution of the Work for the remainder of the Project along with a reallocation of the remaining resources and quantities to represent the estimate to complete the Work as adjusted for Approved Change Orders. A Revised Baseline Schedule must be Approved by CDOT Such Approval shall only apply to the scheduled Work that is planned after the Schedule's Approval date.

The Revised Baseline Schedule shall be prepared by the Contractor when requested by CDOT. The Contractor may request that CDOT review a Revised Baseline Schedule at any time. However, such review will be undertaken if CDOT agrees with the need for that review.

The Revised Baseline Schedule shall be cost loaded to WBS Level VI and summarized for the aggregate costs equal to the WBS Level V prices set forth in the Proposal Documents as adjusted for Approved Change Orders.

2.1.3.2.5 Monthly Progress Schedule

The Approved Original Baseline Schedule, Current Baseline Schedule, or Revised Baseline Schedule shall be used as the basis to establish the Monthly Progress Schedule. It shall be updated every month to show the actual progress of Work and the earned value of Work accomplished, including Approved Change Orders.

The Monthly Progress Schedule shall be cost loaded to WBS Level VI, and when summarized for the aggregate costs of WBS Level V Activities, shall equal the WBS Level IV prices set forth in the Proposal Documents as adjusted for Approved Change Orders. In addition, the Monthly Progress Schedule shall include WBS Level VI detail for the upcoming three months of design and construction on the Project, except that cost loading to WBS Level VI is not required for the three-month look-ahead.

The Monthly Progress Schedules shall be submitted to CDOT for Acceptance with monthly invoices.

2.1.3.2.6 Recovery Schedule

The Recovery Schedule is defined as the Contractor's program and proposed plan for the recapture of lost schedule progress and to achieve Project Completion or Final Acceptance by the applicable Completion Deadlines. The Recovery Schedule shall be based on the latest Accepted Monthly Progress Schedule and shall include equivalent detail. The Recovery Schedule shall show the proposed changes to the Schedule, include cost loading and additional detail to substantiate the recovery plan, and shall reflect all proposed changes to WBS Level VI Activities through Project Completion.

The Recovery Schedule shall be cost loaded to WBS Level VI and, when summarized for the aggregate costs of WBS Level V Activities, shall equal the WBS Level IV prices set forth in the Proposal Documents as adjusted for Approved Change Orders.

2.1.3.2.7 As-Built Schedule

The Current Baseline Schedule, or last Revised Baseline Schedule, submitted shall be identified by the Contractor as the As-Built Schedule. The As-Built Schedule shall reflect the exact manner in which the Contractor executed the Work (including start and completion dates, Activities, actual durations, sequences, and logic), and shall be signed and certified by the Engineer and the Contractor's scheduler as being a true reflection of the way in which the Work was executed at the time of Final Acceptance. This certified As-Built Schedule must be accepted before the final Retainage is released.

The As-Built Schedule shall be accompanied with the Contractor's final quantities with measurement units, type and or classification and in-place unit costs for the following:
Removal of Bridge Structure, Embankment, Unclassified Excavation, Structure Excavation, Structure Backfill, Aggregate Base Course, Lime Treated Subgrade Hot Mix Asphalt, Portland Concrete Pavement,
Bridge Girder, Concrete, Reinforcing Steel, Structural Steel, Guard Rail , Bridge Rail, Pipe, Signing, Tolling Components, Lighting, Traffic Signals, Traffic Control, Public Information and Mobilization.

2.1.3.2.8 Float

Float is defined as the amount of time between the early start date and the late start date, or the early finish date and the late finish date, for each and every Activity in the Schedule. Float shall be for the benefit of all parties to the Contract and not for the exclusive benefit of the Contractor. Suppression or consumption of Float by extended Activity duration, dummy Activities, or preferential sequencing will not be allowed. Critical Activities shall be defined as Activities with a total Float less than 0 Days.

2.1.3.3 Schedule Requirements

1. General Scheduling Constraints

   A. All Contract Schedules shall be in the same master data file, including design, submittals, procurement, and construction Schedules. These Work Activity Schedules shall all tie together logically to present a total Critical Path analysis in the same master data file.

   B. The only constraints allowed to be included in the Schedule are the Contract Deadlines. No intermediate completion constraints or start constraints shall be allowed unless they are included in the Contract. Unless Approved by CDOT, all Activities must have at least one predecessor and one successor, except for the NTP1 (no predecessor) and Final Acceptance (no successor).

   C. All Activities that start or complete out of sequence shall be rescheduled (logic corrected) to reflect the actual sequence of events.

   D. Actual start and completion dates shall be accurately input. Prior to changing or correcting any previous actual dates, or dates required in the Contract, a narrative shall be written to CDOT requesting Approval to change such a date.

E. If any logic is changed after the Approval of the Original Baseline Schedule or Revised Baseline Schedule, if one exists, a narrative by Activity code shall accompany the Monthly Progress Schedule stating the reason the logic changed and the benefit to CDOT. If CDOT does not agree with the reason for the logic change, the Monthly Progress Schedule will not be Accepted.

F. All Activity identification codes for a specific Activity description created in any Contract Schedule shall remain unchanged and connected to its original Activity description through Final Acceptance. An Activity description may only be changed to clarify an Activity's original scope.

2. CPM Requirements

A. The Critical Path shall be determined according to Critical Path Method (CPM) principles and shall be highlighted in "RED" on all Schedules to distinguish critical Activities from other Activities. A diamond, flag, or other symbol shall highlight milestones.

B. The CPM shall have all major procurement Activities identified for any item with more than 30 Days lead time for delivery. This includes Shop Drawing submittal and approval, lead times for the fabrication and delivery of Materials and Equipment, and installation of Materials and Equipment.

C. The CPM shall be sufficiently detailed to accurately depict all the Work. Activity durations shall be an estimate in Working Days of the time required to perform each Activity. No individual Activity will have a duration exceeding 30 Working Days without prior approval from the Project Director. Activities with durations of less than 5 Working Days shall be held to the absolute minimum. For an Equipment or Material fabrication item whose duration exceeds 30 Working Days, several Activities, none exceeding 30 Working Days, shall be used. Each Activity shall have a detailed description.

D. Contract Completion Deadline dates shall be shown on the CPM. These dates shall be input as finish constraint dates and shall agree with such dates specified in the Contract.

3. Schedule Output Format

The Contractor shall submit the electronic output files of the Schedule (e.g., .mpx for MS Project). Its Schedule charts and graphs shall be submitted in Adobe PDF. These files shall be submitted with the Monthly Progress Schedule.

2.1.3.4 Execution

2.1.3.4.1 WBS Activities and Schedule Modifications

When it becomes necessary to add, combine, eliminate or modify Contract-specified WBS Level IV, V, or VI or Activities to reflect modifications to the Work, such changes shall be made

through a Change Order that has been approved by CDOT in accordance with the Contract. These changes to the WBS Level V Activities shall consequently be reflected in subsequent Schedule submittals. Alternately, if a proposed addition, combination, elimination, or modification of WBS Level V or VI Activities would not be the subject of a Change Order, then the consequent realignment of funds between Level IV Schedule Activities must be approved by CDOT in accordance with the Contract and thereafter reflected in the required Schedule submittals.

2.1.3.4.2 Preliminary Baseline Schedule

The Contractor shall submit the Preliminary Baseline Schedule to CDOT for Acceptance prior to NTP1. The Preliminary Baseline Schedule shall be in accordance with the Contract requirements, consistent with the Accepted WBS, and be cost loaded to WBS Level VI Activities and include Contractor-defined detail necessary to provide measurable Schedule progress. The Accepted Preliminary Baseline Schedule shall provide an intermediate Schedule during the production of the Original Baseline Schedule and shall establish a payment schedule for the duration between NTP1 and NTP2.

2.1.3.4.3 Original Baseline Schedule

The Original Baseline Schedule shall show the sequence and interdependence of Activities required for complete performance of the Work, beginning with the date of the NTP1, and concluding with the date of Final Acceptance and shall comply with the following:

1. The actual number of Activities in the Schedule shall be sufficient to assure adequate planning of the Work and to permit monitoring and evaluation of progress and the analysis of time impacts. Activity durations shall be expressed in Working Days. The Work calendar shall clearly identify Holidays and other non-Working Days, as well as Special Events.

   Special Events include, but are not limited to events identified under the requirements of Book 2, Section 16, Maintenance of Traffic. This list shall be further developed as progress is made for Work included in Book 2, Section 4, Public Information and Book 2, Section 16, Maintenance of Traffic.

2. The Contractor shall schedule deliverable review times by CDOT and Governmental Approvals as separate tasks logically tied to the appropriate Activity. Concurrent review of multiple deliverables by one discipline must be agreed to by CDOT, prior to inclusion in the Original Baseline Schedule.

3. A graphic representation of all Activities necessary to complete the Work shall be provided.

4. All Completion Deadlines set forth in the Contract shall be identified.

Not later than 90 Days after issuance of NTP1, the Contractor shall submit to CDOT for Approval the final Original Baseline Schedule. Once approved, this schedule shall become the Original Baseline Schedule against which all progress and revisions shall be measured.

The Original Baseline Schedule will be reviewed by CDOT for purposes of determining:

1. Compliance with applicable provisions of the Contract Documents.

2. The logic of the proposed CPM schedule is sound and consistently developed and demonstrates a logical sequencing and interdependence of Activities required for the timely and orderly achievement of all Work Activities and milestones, including completion of the Work within the Completion Deadlines.

Upon Approval by CDOT, the Original Baseline Schedule shall be employed as the basis for the Monthly Progress Schedule by the Contractor in its scheduling and performance of the Work.

2.1.3.4.4 Monthly Progress Schedule

The Monthly Progress Schedule shall be submitted each month to CDOT for Acceptance, concurrent with the invoice submittal as required herein. The Monthly Progress Schedule shall include all information current as of the status date.

For the three-month look-ahead portion of the Monthly Progress Schedule that establishes the WBS Level VI Activities, the Contractor shall provide sufficient detail to convey a Schedule that provides weekly Schedule control and shall specifically identify:

1. Completion Deadlines, if any.

2. Phasing of design, construction, testing, and staging of the Work as specified shall be prominently identified. Particular attention shall be given to release for construction dates, Site availability, construction staging, and maintenance and protection of traffic requirements of the Contract.

3. Procurement, fabrication, preparation of mock-ups, preparation of prototypes, delivery, installation, testing of Materials, and Equipment, including factory testing and demonstration testing, and any long lead time (over 30 Days) orders for Material and Equipment.

4. Interface coordination and dependencies with preceding, concurrent, and follow-on Contractors.

5. Work to be performed by other Contractors and agencies that may affect the Schedule.

Prior to the progress status meeting, the Contractor shall obtain from the design team, Subcontractors, Suppliers, and field staff the necessary information as required to accurately reflect progress to date.

2.1.3.4.5 Recovery Schedule

If the Work is lagging the late start cost curve in the Current Baseline Schedule for a period which exceeds the greater of, (a) 15 Days in the aggregate or (b) that number of Days in the aggregate that equals 5 percent of the Days remaining until the Project Completion Deadline. The Contractor shall prepare and submit to CDOT for Approval a Recovery Schedule within 14 Days after the Contractor first becomes aware of such Schedule delay.

The Recovery Schedule shall demonstrate the Contractor's program and proposed plan to regain lost Schedule progress, as well as demonstrate how Project Completion and Final

Acceptance of the Project shall be achieved by the deadlines specified in Exhibit B of the Contract.

CDOT will notify the Contractor within 14 Days after receipt of the Recovery Schedule whether the Recovery Schedule is Approved, or will describe changes that CDOT believes should be made to the Schedule. The Contractor shall incorporate and fully include the Recovery Schedule (including CDOT's comments) into the next scheduled Monthly Progress Schedule (or, if the next scheduled Monthly Progress Schedule is due within 7 Days of Approval of the Recovery Schedule, then the Recovery Schedule shall be incorporated into the subsequent Monthly Progress Schedule), and shall concurrently provide to CDOT a Revised Baseline Schedule.

2.1.3.4.6 Payment Schedule

This is a multi-year construction contract. As such Standard Special 108 and 109 discusses the monthly payment schedule requirements. It also discusses projected year of expenditure by the contract as compared to year of expenditure encumbrance. Contractor shall coordinate with CDOT to ensure the monthly payment schedule minimizes differences between the annual expenditure versus encumbrance.

2.1.4 Meetings

2.1.4.1 Task Force Meetings

At a minimum, the Contractor shall conduct Task Force Meetings for the following disciplines to facilitate "Over the Shoulder" review of the design. At a minimum the following discipline reviews shall be undertaken:

1. Drainage
2. Roadway
3. Structures
4. Traffic/ITS
5. Utilities
6. Environmental
7. Public Involvement

The Contractor shall include appropriate stakeholders in Task Force Meetings. This would include the appropriate local Traffic Engineers, Parks and Recreation, Engineering, impacted Utilities and others.

2.1.5 Photographs

2.1.5.1 Progress Photographs

The Contractor shall take aerial Project photographs of the Work and Site every 6 months as a minimum. Aerial photographs shall include all areas under construction, whether temporary or permanent, and all other areas impacted, each time they are taken. One series of oblique

photographs shall be taken from one direction along the corridor. CDOT's confirmation shall be sought regarding views to be taken and the approximate time at which they will be taken.

The Contractor shall provide one complete set of aerial photographs on DVD when taken. All photographs shall be provided in high quality digital format. The file format shall be .jpg, .gif, or .tiff and be provided on DVDs.

The Contractor shall provide interior and exterior photographs of each buried structure just prior to burial. Provide a minimum of four internal views (as applicable) and four external views of each structure. Place the following information on the front of digital photographs:

1. Date photograph was taken
2. Title of Project
3. Description and location of structure and structure number if available
4. Description of view shown in photograph
5. Identification of photographer
6. Sequential number of photograph

2.1.5.2 Pre-Construction Photographs

Immediately after NTP1, the Contractor shall take and label a sufficient number of pre-construction photographs and a high quality video of the Site, including Roadways, Structures, Drainage, existing Landscape, and all areas necessary and/or anticipated to be impacted by the Work, including haul and detour routes in HD format so as to resolve any disputes which may arise regarding the conditions prior to and subsequent to construction. Such preconstruction survey shall be completed prior to NTP2. If a dispute arises where no or insufficient photographic or video evidence of its existing condition is available, the disputed area shall be restored to the extent directed by CDOT at no additional cost to CDOT.

2.2 Office Facilities and Options

2.2.1 Office

The Contractor shall provide all office space, and equipment, for CDOT as required for the Project. This will be co-located with the Contractor. Individual CDOT and Contractor offices within the co-located office space shall not be intermingled.

The Contractor shall provide office space (the CDOT Offices) and Equipment for 29 CDOT personnel as specified herein.

The Contractor shall make available its proposed facilities for inspection and Approval by CDOT prior to CDOT occupying any Contractor provided facilities not later than 30 Days after the execution and delivery of the Contract. The Contractor shall be required to furnish CDOT's staff with Class B or better office space, for Approval, that is in good and serviceable condition and be located within or directly fronting the boundary identified in Exhibit B. Both parties shall participate in a facility condition inspection prior to and at the completion of occupancy. CDOT will return possession of Contractor-provided facilities to the Contractor in essentially the same condition as when CDOT initially occupied the facilities except for reasonable wear and tear.

The Contractor shall secure Sites; obtain all Site permits; install, set up, and provide Utility services; and maintain the facilities as part of the Work. The Contractor may consult with CDOT about availability of suitable local sites and office facilities.

In the event that office spaces or appurtenant facilities are stolen, destroyed, or damaged during the Work, except by fault of CDOT, the Contractor shall at its expense repair or replace those items provided to their original condition within 5 Working Days. If loss or damage is caused by CDOT personnel, the Contractor shall replace the facilities within 5 Working Days, except CDOT will be responsible for costs incurred.

The Contractor shall maintain the CDOT Offices until at least 90 Days following the Final Acceptance of the Project unless otherwise agreed to by CDOT. CDOT may, at its option, vary the number of its staff throughout the duration of the Project. However, the Contractor shall maintain the initial number and size of the CDOT Offices, conference rooms, reception area, break room and filing area (the CDOT Office Facilities) until 90 Days following the Final Acceptance of the Project.

The Contractor shall be responsible for disposal or removal of all CDOT Office Facilities and any site restoration Work required.

The Contractor shall provide:

1. Telephones and telephone service with at least two lines for CDOT Offices, conference rooms, break room, and filing room, including five cordless phones.
2. One fax machine with a dedicated telephone line.
3. High-speed Internet connection (10 mps or greater) and networking for all offices including wireless access..
4. Overhead lighting meeting Occupational Health & Safety Administration (OSHA) and code requirements for office space.
5. One color laser printer, copier, with additional 11- by 17-inch tray or Approved equal, including paper, toner, parts, service, and repairs. This printer shall be capable of networking to all CDOT personnel offices. The printer shall be capable of scanning documents to 11- x 17-inch size and transmitting the scanned file to multiple email addresses
6. One color copier capable of 45 ppm input and output at 600 x 600 dpi and at least two paper drawers accepting 8-1/2- x 11-inch up to 11- x 17-inch paper and paper weights from 16 to 24 lb. bond, including paper, toner, service and repairs.
7. Office space not less than the size indicated below:
    A. 8 private offices (with locking doors): 150 square feet of enclosed office space per office.
    B. 21 partitioned offices (without door): 100 square feet enclosed office space per office (cubicles/partitions are acceptable).
    C. One enclosed conference room with doors capable of accommodating a 30-person meeting, with at least 50 percent of seating capacity at the conference table. This can be a shared conference room between the Contractor and CDOT.

D. One enclosed conference room with doors for CDOT's exclusive use capable of accommodating a 20-person meeting, with a 15-person seating capacity at the conference table. The conference room shall be in an adjacent space to the CDOT Offices.

E. Break room: 150 square feet with sink, counter, microwave, and 20-cubic-foot refrigerator, and drinking water and dispenser.

F. Filing space: enclosed, with lockable door and 2 steel, 5-drawer, locking, lateral file cabinets (approximate size = 18 inches by 42 inches). The file room shall also have two 30- x 72-inch utility tables with two chairs each and 2 bookshelves 36 x 72 inch. This space shall be of sufficient size to accommodate the requested equipment and accommodate two staff members (to typical industry standards). This space shall not be shared with any other room.

G. One reception area with common access to the CDOT Offices.

H. Storage room: 150 square feet, enclosed with lockable door.

8. Furnishings, as follows:

Conference Room

A. Conference table and chairs

B. Wastebasket

C. Two hanging and erasable white boards that are six feet wide minimum

D. Projector and screen

Offices

A. Desk that is minimum size 76 x 36 inches with locking drawers

B. Computer workstation desk capable of holding a desktop printer, monitor, keyboard, and any accessories

C. Worktable (36 x 76 inches) (private offices only)

D. Ergonomically correct, OSHA-approved chairs

E. Extra office chair

F. Hanging, erasable white board, 4 feet wide, minimum (private offices only)

G. Bookshelf (1 for partitioned offices and 2 per each private office 36 x 72 inches)

H. Wastebasket

9. Indoor restrooms suitable to accommodate the office staff (separate men’s and women’s).

10. Hard-surfaced (paved) parking, one space per employee, plus 10 visitor spaces.

11. Daily janitorial service (except weekends and holidays).

12. Maintenance of the exterior area of office, including access to parking and snow removal.

13. Facilities that meet American with Disabilities Act (ADA) access requirements and meet all local code requirements for office space.
14. Heating, ventilation and air conditioning/cooling systems adequate for office use.
15. 24 hours a day, 7-days a week access with security after normal working hours.

2.2.2 Design-Build Field Laboratory (Owner Testing)

The Contractor shall provide one Field Laboratory Class 2 and one Field Laboratory Class 2 (with an ignition furnace) as per CDOT *M & S Standard Plans*, at a location to be agreed upon by CDOT and the Contractor. The field Laboratory shall have a minimum of three parking spaces, all contained within a security fence. The field Laboratory shall be provided to CDOT at least 20 Working Days prior to commencement of any field Activities involving earthwork of any type, analysis of mix designs, or planned placement of Portland Cement Concrete Pavement (PCCP) or Hot Bituminous Pavement (HBP) and shall have a forced air oven and high-speed Internet connection.

2.2.4 Project Vehicles

Intentionally left blank.

2.2.5 Project Directory

The Contractor shall maintain and furnish to CDOT a Project Directory listing the names, addresses and telephone numbers (office, home, cellular, etc.) of the Key Personnel and critical support staff of the Contractor and each Subcontractor. The Project Directory shall be submitted to CDOT prior to issuance of NTP2. The Contractor shall update the Project Directory quarterly for the duration of the Work.

2.3 Safety Management

2.3.1 Project Safety Management Plan Submittal

The Contractor's Project Safety Management Plan (PSMP) (CDOT *Standard Specifications for Road and Bridge Construction*, 107.06) must be submitted for review and Acceptance prior to receiving NTP2.

The PSMP is a living document and shall be updated when a process, method, chemical or other Work criteria changes that affects the safety of a person or property. The updated portion of the PSMP must be submitted for review.

2.3.2 Project Safety Management Plan Criteria

The PSMP must answer the "who, what, and how" based upon the technical requirements contained within Book 2 of the RFP and the 12 elements identified in the CDOT *Standard Specifications for Road and Bridge Construction*, 107.06.

2.3.3 Project Safety Management Plan Training and Communication

All Contractors Project staff, including CDOT and Subcontractors, must be trained on the elements of the Contractor's accepted PSMP submittal.

2.3.4 Safety Meetings

The Contractor shall conduct regularly scheduled Project Safety Meetings, tool box talks, etc., as specified in their Project Safety Management Plan & as per the Standard Specifications.

2.4 Document Management

The Contractor shall establish and maintain its own Document Control System (DCS) to store and record all correspondence, drawings, progress reports, technical reports, specifications, Contract Documents, deliverables, calculations, and administrative documents generated under the Contract. Document Control, storage, and retrieval methods shall include the use of both hard copies and electronic records. The Contractor's DCS shall handle all Project documents utilizing Aconex construction project management software.

All correspondence of the Contractor to and from CDOT and its representatives with respect to the Contract shall be serialized, and the Contractor shall maintain separate incoming and outgoing correspondence logs. At a minimum, a serialization similar to the following is required:

DATE:_____

DBC Assigned No.:_____

DB-(year):_____

Addressee:_____

Address:_____

Subject:_____

- ☐ Information
- ☐ Review
- ☐ Acceptance
- ☐ Approval

Reference:_____

Copies:

Example Document Serialization

All correspondence shall include the Project name, Contract name and number, along with the specific subject of the letter. All replies shall refer specifically to prior correspondence to which it relates.

The Contractor shall make available through a single point of contact, when requested by CDOT, copies of its logs indicating CDOT's outstanding items and a copy of any document requested within 24 hours.

Document Management and Control shall also conform to the requirements of Section 3, Quality Management.

2.4.1 Document Management System

The Contractor shall transmit all required deliverables and other documents to CDOT via CDOT's Document Management System (Aconex). The Contractor shall provide access to the Document Control System for CDOT personnel.

2.5 Deliverables

The Contractor shall submit the following to CDOT for Approval, or and/or Acceptance:

Deliverable	Review, Acceptance or Approval	Schedule
Preliminary Baseline Schedule & WBS	Acceptance	Prior to NTP1
Methods Statements	Acceptance	Prior to NTP2
Draft Monthly Invoices	Acceptance	Within 10 Working Days following prior month's end concurrent with the progress status meeting
Final Monthly Invoices	Approval	According to Section 2.1.2.4
Monthly Progress Report format	Acceptance	Within 10 Working Days after NTP1
Monthly Invoice format changes	Approval	At least 15 Days prior to first invoice and before NTP2
Monthly Maintenance Progress Report	Acceptance	With each Monthly Invoice
Original Baseline Schedule	Approval	No later than 90 Days after NTP1 and prior to NTP2
Current Schedule	Acceptance	Concurrent with Monthly Invoice
Revised Schedule	Approval	Upon CDOT's or Contactor's request
Progress Photographs	Acceptance	According to Section 2.1.5
Pre-Construction Video/Photographs	Acceptance	Prior to NTP2
Monthly Progress Schedule	Acceptance	Concurrent with Monthly Invoice
As-Built Schedule	Acceptance	Before the release of final Retainage
Recovery Schedule	Approval	According to Section 2.1
Changes to Schedule Requirements	Approval	According to Section 2.1
Office Facilities and Options	Approval	(see requirements in Section 2.2)
Project Directory	Acceptance	Prior to NTP2
Project Safety Management Plan (PSMP)	Acceptance	Prior to NTP2 or any work element requiring implementation of the Safety Plan.

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

2.6 Exhibits

Exhibit A –WBS Activities

Exhibit B – Field Office Location Boundary

WORK BREAKDOWN STRUCTURE

C-470 Tolled Express Lanes Segment 1 Program

DESIGN / BUILD CONTRACT

- **Project Management**
  - ★ Project Administration
  - ★ Quality Management
  - ★ Design Quality
  - ★ Construction Quality
    - Process Control (PC)
    - Independent Contractor Quality Control (ICQC)
  - ★ Public Involvement
  - Mobilization
  - Railroad Flagging and Inspection
- **Utilities**
  - Aurora Water
  - Army Corp of Engineers
  - CDOT
  - Centennial WSD
  - Denver Water
  - East Cherry Creek Valley WSD
  - Ken Caryl Ranch WSD
  - Lockheed Martin Astronautics
  - Lone Tree (City of)
  - Meadowbrook
  - Northern Douglas County WSD
  - Park Meadows Metro
  - Platte Canyon WSD
  - Roxborough WSD
  - Southgate WSD
  - South Metro Water Supply Auth.
  - Southwest Metropolitan WSD
  - Willows WSD
  - Private Utilities
- **Design**
  - Preliminary Design Plans (30%)
  - Pre-Released for Construction (RFC) Review Documents
    - (by Package)
  - Final RFC Documents
    - (by Package)
  - Final Design Plans (100%)
  - As-Built Design Plans
- **Geotechnical and Pavements**
  - (by Area)
    - (by Phase)
      - (by Stage)
- **Earthwork**
  - (by Area)
    - (by Phase)
      - (by Stage)
- **Drainage**
  - "Special Outfalls"
  - Other Drainage (by Area)
    - (by Phase)
      - (by Stage)
  - Permanent Stormwater Management
- **Bridges and Minor Structures**
  - SB I-25 Ramp o/RTD
    - (by Phase)
      - (by Stage)
  - NB I-25 Ramp Connect
    - (by Phase)
      - (by Stage)
  - SB I-25 Direct Connect
    - (by Phase)
      - (by Stage)
  - SB I-25 Ramp Connect
    - (by Phase)
      - (by Stage)
  - Yosemite
    - (by Phase)
      - (by Stage)
  - Acres Green Drive
    - (by Phase)
      - (by Stage)
  - Big Dry Creek
    - (by Phase)
      - (by Stage)
  - S. University
    - (by Phase)
      - (by Stage)
  - S. Broadway
    - (by Phase)
      - (by Stage)
  - S. Erickson
    - (by Phase)
      - (by Stage)
  - S. Platte River
    - (by Phase)
      - (by Stage)
  - Other Structures
    - (List Each Structure)
- **Walls**
  - Retaining Walls
    - (by Area or Wall)
      - (by Phase)
  - Noise Walls
    - (by Area)
      - (by Phase)
- **Environmental Management**
  - Landscaping
    - Temporary Stormwater Management
      - (by Area)
        - (by Phase)
  - Other Permit Compliance
- **Signing, Pavement Marking, Signalization, Lighting**
  - (by Area)
    - (by Phase)
      - (by Stage)
- **ITS and Tolling**
  - (by Area)
    - (by Phase)
      - (by Stage)
- **Maintenance of Traffic**
  - (by Area)
    - (by Phase)
      - (by Stage)
- **Maintenance During Construction**
  - ★ 2016 Maintenance
  - ★ 2017 Maintenance
  - ★ 2018 Maintenance

WBS - LEGEND

Level I	
Level II	
Level III	
Level IV	
Level V	
Level VI	

WBS Notes:

Area: A specific grouping of Work along the Project defined by the Contractor which creates segments of the Project for the purpose of planning and executing the Work.

Phase: A specific sequence of the construction Work in an Area during which a major traffic movement is redirected (e.g., a detour) and left in place until the Work is complete and traffic is redirected to another location.

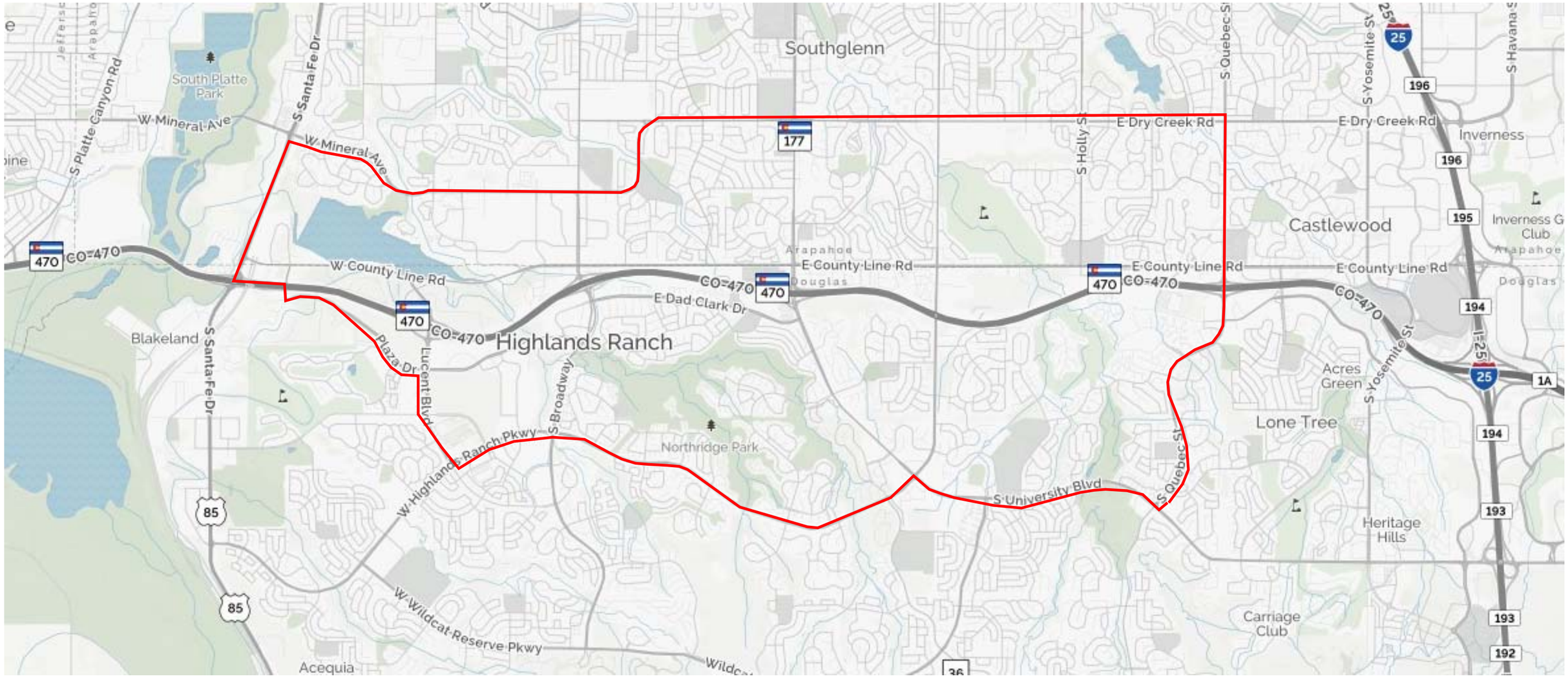
Stage: A subdivision of Work within a Phase which combines similar components of Work to maintain efficiency. Sub-division below this level is at the Contractor's convenience.

★: Cost loading shall be a straight line distribution over each year over the term of the Contract.

1/13/2016

Book 2 - Section 2
EXHIBIT B
FIELD OFFICE LOCATION BOUNDARY

Boundary for Allowable
Field Office Location



3.0 QUALITY MANAGEMENT

The Contractor shall be responsible for implementation and maintenance of an effective quality program to manage, control, document and assure all obligations of the Contractor comply with the requirements of the Contract Documents for the project. The QMP shall encompass all Work performed by the Contractors of all tiers and its overall Quality Assurance program, including at a minimum a Process Control Plan, Independent Contractor Quality Control Management Plan and a Design Quality Management Plan (DQMP).

The QMP shall describe, in detail, the Quality processes related to including internal checks, reviews, audits, responsibility and authority, and resolutions to occurrences of non-conformance to Contract requirements. The QMP shall address the responsibility and Approval authority of CDOT and outline processes for addressing issues related to elements of Work that do not comply with the Contract. The QMP shall include the Contractor's quality policy, quality planning and quality improvement processes.

QMP shall be in effect until Final Owner Acceptance and will address the responses to Warranty issues during the Warranty period.

3.1 Administrative Requirements

The Contractor shall submit the QMP for design related Work to CDOT and other activities that Contractor is performing prior to NTP 2 for Approval prior to issuance of NTP1. CDOT will deliver its Approval or disapproval and provide comments on the initial QMP submission within ten Working Days following CDOT's receipt of the QMP. The Contractor shall revise its QMP within seven Working Days upon notification by CDOT of disapproval and comments.

The entire QMP for all of the Work on the Project must have CDOT's Approval before NTP2 will be issued. CDOT will deliver its Approval or disapproval and provide comments on full QMP submission within 15 Working Days following CDOT's receipt of the QMP. The Contractor shall revise its QMP within 10 Working Days upon notification by CDOT of disapproval and comments.

3.1.1 Quality Policy

The QMP shall include the Contractor's executive management written definition and endorsement of the Contractor's policy for quality, including objectives and its commitment to quality. The QMP shall delineate procedures used by the Contractor's executive management to implement the Contractor's quality policy. The Contractor's executive management shall ensure that its policy is implemented at all levels of the organization.

The Contractor shall publish and post a statement of its commitment to quality, and the organization's quality objectives, in several locations throughout the Project. The statement shall explain the Contractor's commitment to quality and the responsibility the Contractor has for assuring that it meets the quality requirements for the Project.

3.1.2 Quality Planning

The Contractor shall include in the QMP its planning methods to meet the requirements of the Contract. The Contractor shall include the following activities, at a minimum, in its quality planning efforts to ensure continued conformance to Contract requirements:

1. Identify the necessary processes, resources, and personnel that are needed for Design Process Control, Independent Design Quality Control, Construction Process Control and Independent Contractor Quality Control (ICQC), to assure the Work meets the requirements of the Contract.
2. Develop processes to ensure all project personnel are trained in the implementation of the QMP
3. Include procedures to develop and maintain the currency of Process Control, ICQC, and quality improvement.
4. Identify and define all measurable Contract requirements.
5. Develop procedures for preparation, control, Approval, and distribution of the QMP.
6. Develop procedures for internal quality auditing to ensure the Contractor employees, Subconsultants, Subcontractors, and Suppliers understand and are effectively implementing the QMP. The Contractor, as a minimum, shall audit the implementation of the QMP on a quarterly basis.
7. Identify the process to ensure the Contractor's executive management approves and endorses the QMP, and reviews the implementation of QMP throughout the duration of the Project.

3.1.3 Quality Assurance

The Contractor shall be responsible for Project Quality Assurance that includes all planned and systematic actions necessary to provide confidence that the project will perform satisfactorily in service. The Contractor's Quality Assurance procedures will include Quality Processes to ensure the Quality of the production Work and Independent Contractor Quality Control (ICQC) testing and inspection of the Work.

3.1.4 Quality Improvement

The Contractor shall establish, document, and implement a program for quality improvement. The Contractor shall include in the QMP the methods for identifying, analyzing, evaluating, and implementing solutions to continuously improve quality. The QMP shall establish and maintain specific procedures to ensure a successful Quality Improvement Program.

The Contractor's quality improvement program shall include internal quality audits and regularly scheduled quality meetings with staff and supervisors to discuss quality issues.

3.2 General Roles and Responsibilities

3.2.1 Contractor Roles and Responsibilities

The Contractor shall establish, document, and implement a Quality Management Plan (QMP) The QMP shall include all procedures necessary for the Contractor to control the quality of its design and construction processes to meet the requirements of the Contract. The QMP shall include a testing and inspection schedule to control the construction processes.

The Contractor shall provide a Process Control (PC) team to implement to monitor, assess and adjust the production to ensure the final products meet the contract requirements.

The Contractor shall provide a qualified Independent Contractor Quality Control (ICQC) team to perform Quality Control inspections and testing. The ICQC staff shall remain independent from production PC. The ICQC Team will perform on-site inspection and testing of the construction elements of the Work to verify that all Work has been constructed in conformance with the Contract requirements. ICQC personnel shall not perform any other role on the Project.

The Contractor will provide a qualified design quality team which shall oversee the design processes of the Project by conducting design reviews, providing review documentation, and coordinating with the Contractor and CDOT to ensure that the design meets the requirements of the Contract.

3.2.2 CDOT Roles and Responsibilities

CDOT will retain responsibility for the Owner Acceptance (OA), as required by Title 23, Code of Federal Regulations, Part 637 (23 CFR 637). CDOT will include the results of the Contractor's auditing and acceptance testing in its acceptance decisions.

CDOT will perform Owner Verification using a testing and auditing sampling approach to assess the Contractor's compliance with the requirements of the Contract Documents. CDOT reviews of sampled Work for Contract compliance are defined as Verification reviews.

CDOT will perform Independent Assurance activities to confirm that the sampling and testing activities performed by the Contractor's ICQC team are conducted by qualified personnel using proper procedures and properly calibrated and functioning equipment.

3.3 Personnel Requirements

The Contractor shall include in the QMP an organizational chart that illustrates a commitment to an effective quality program to ensure all Work meets the requirements of the Contract. The QMP shall describe the hierarchy of the Contractor's organization. The QMP shall graphically depict the principal quality participants showing lines of responsibility, authority and communication with CDOT, other involved agencies, Subconsultants, Subcontractors, and Suppliers and any other team members having a significant quality role.

The Contractor's executive management shall have overall responsibility for successful execution of the QMP and shall ensure that responsibilities and authority are defined and communicated within their organization. The Contractor shall identify a Quality Control Administrator (QCA) that reports directly to executive management and shall be responsible for all Contractor design and construction quality activities for the Project. The Quality Control Administrator cannot be responsible for the management and direction of Process Control activities.

3.3.1 Contractor's Quality Team Key Personnel

Quality-related Key Personnel are the design-build Quality Control Administrator (QCA), also referred to as the Design-Build Quality Manager, Design Quality Manager (DQM), and the Construction Quality Manager (CQM). The QCA and the CQM will be employed by the ICQC firm shall not be employees of the Contractor's, or its subcontractors. The QMP shall identify the persons who will fill the Quality-related Key Personnel roles. The QCA and CQM shall be co-located at the Project offices.

The Contractor shall not replace any quality Key Personnel without prior Approval from CDOT. Personnel replacements must have equal or better qualifications as determined by CDOT.

1. Quality Control Administrator (QCA), also referred to as the Design-Build Quality Manager

   The QCA shall be responsible for certifying the overall Quality of the Project, including design, construction, management, and administrative processes, and for providing evidence of compliance to the Contract requirements. The QCA shall report directly to an executive management committee including representation from the leadership of CDOT and the Contractor's team. At a minimum, the QCA shall provide monthly status reports of the Project's quality to CDOT.

   A request to replace the QCA shall name a proposed replacement manager and their qualifications. The proposed replacement must be on-site within 15 Working Days of CDOT Approval of the change. The QCA shall not have any other project responsibilities. The QCA shall be a registered Professional Engineer in the State of Colorado. The Contractor shall have an Approved Quality Control Administrator available at all time during the Project.

2. Design Quality Manager (DQM)

   The DQM shall report directly to the QCA and shall be responsible for verifying the quality of the design elements of the Project.

3. Construction Quality Manager (CQM)

   The CQM shall report directly to the QCA and shall be responsible for verifying the quality of the construction elements of the Project.

3.3.2 Independent Contractor's Quality Control Team Staff

ICQC Team shall be an independent testing/engineering firm employed by the Contractor solely to provide ICQC work, and separate from the Contractor's Process Control team. The ICQC firm may be a member of the Contractor's design team provided it has performed less than 20% of the design work (by dollars). The professional training and experience of the ICQC Team staff shall be commensurate with the scope, complexity, and nature of the activity to be checked, inspected, monitored, or tested, to include at a minimum the requirements identified in Table 3-1.

Table 3-1 Quality Staff Certification Requirements			
CDOT Class/Certification	**Construction Quality Manager (CQM)**	**Inspector**	**Materials Testing Technician (MTT)**
Basic Highway Math	X*	X*	X
Basic Construction Surveying	X*	X*	X
Basic Highway Plan Reading	X*	X*	X
Storm water Management and Erosion Control	X	X	
CCA Traffic Control Supervisor	X	X	
Laboratory for the Certification of Asphalt Technicians (LabCAT) Level A & B			X
Asphalt Paving Inspection LabCAT Level 1		X	X
Colorado Ready Mix Concrete Association (CRMCA) Concrete Paving Certification		X	X
Excavation and Embankment		X	X
WAQTC			X
ACI Field Testing Tech 1			X

*Not required if a licensed Professional Engineer or has an engineering degree from an accredited institution.

ICQC staff may not include individuals who are employees of, or retained by, manufacturers, vendors, or suppliers.

3.3.3 Training

The Contractor shall establish and maintain documented procedures for identifying training needs and requirements for the implementation of the QMP and shall provide training of all personnel performing activities affecting quality. Personnel performing specific assigned tasks affecting quality shall be trained in the specific plans, processes, and procedures as assigned in the QMP.

The QMP shall specify procedures that:

1. Familiarize all personnel with all requirements of the Contract documents including the proposal documents pertaining to their responsibilities.
2. Educate, train, and certify (as appropriate) personnel performing activities affecting or measuring the Quality of the Work and ensure that they achieve and maintain reasonable proficiency.

3. Ensure that personnel performing the Work do so according to the QMP and all other Contract documents.
4. Provide formal training on the proper use and procedures for document control prior to implementation.
5. Provide documentation verifying all training efforts and activities.

The Contractor shall provide training to all personnel that may interface with CDOT's Owner Acceptance (OA) efforts to ensure they understand their roles and responsibilities for cooperating and responding to CDOT OA activities.

Training efforts shall precede the associated Work.

3.4 Documentation

Document management and control shall conform to the Contract requirements, including Section 2, Project Management.

3.4.1 Documentation Control

The Contractor will provide a web-based portal (Portal) to facilitate electronic submission of documentation to CDOT, utilizing Aconex construction project management software.

The Contractor shall establish and maintain a document control system (DCS) for meeting documentation requirements for the filing of design criteria, reports and notes, calculations, plans, specifications, schematics, project administration, supporting materials, etc. and for the specific responsibilities of personnel to satisfy these requirements. All documents required by the Contract to be submitted to CDOT by the Contractor are required to be organized, indexed, transmitted to, and maintained in the Portal throughout the duration of the Project.

All documentation submitted to the Portal shall be properly attributed to allow for future retrieval within the system. File naming conventions and other attributes shall be developed with the intent of allowing for and contributing to easy access and retrieval of any and all documents related to any item(s) of the Work including the ability to allow for cross discipline queries within the Portal. The QMP shall include the proposed file structure and naming conventions for all required quality documentation.

The DCS will identify (by name) the document control supervisory personnel for the maintenance and management of records and documents pertinent to the Contractor and Department activities.

The records shall include factual evidence that required inspections or tests have been performed, including type and number of inspections or tests involved; results of inspections or tests; nature of Nonconforming Work and causes for rejection, etc.; proposed remedial action; and corrective actions taken. The records shall cover both conforming and nonconforming Work, and shall include statements that all supplies and materials incorporated in the Work are in full compliance with the Contract Documents.

The Contractor’s Construction Quality Manager shall maintain a daily log of all inspections performed for both Contractor and Subcontractor operations. The daily inspection reports shall identify inspections conducted, dates of inspections, results of inspections, locations and nature

of defects found, causes for rejection, and remedial or corrective actions taken or proposed. The responsible technician and the technician's supervisor shall sign the daily inspection reports. These daily inspection reports shall document the day's events, activities, and discussions in a format consistent with the requirements contained within CDOT*'s Field Materials Manual* and *Construction Manual*.

The Contractor shall submit all ICQC test measurements and test results, including failing results, and inspection records. The Contractor shall submit test data and approved test and inspection results to the Department for Acceptance within 48 hours following the inspection or test. The responsible technician and the technician's supervisor shall sign the daily test reports

To enhance coordination of the CDOT's acceptance activities during construction, the Contractor shall provide the Department with a weekly look ahead of specific scheduled construction activities designating location and planned quantities of materials to be placed, and protocols for identifying completed construction Work. The Contractor shall also provide the CDOT with the actual construction activities conducted during the previous week, designating location and quantities of materials that were placed.

The Contractor's records shall include a master list of approved design submittals, revisions and field design changes. The QMP shall include a process to communicate design changes to the construction Site on a timely basis consistent with the progress of construction activities.

3.4.2 Request for Information

The QMP shall define a system to control the Request for Information (RFI) process for both Design- Builder and Third Party generated issues, and identify who is required to respond to the RFI. CDOT will be included in the distribution of all RFIs. CDOT concurrence shall be obtained prior to formally issuing a RFI response. If nonconforming work is discovered through the RFI process it shall be addressed with the Nonconforming Work process described in Section 3.6.

3.4.3 Design Review Documentation

The QMP shall outline a process to maintain a written record of all design reviews.

The written record shall include but not limited to the following:

- Lists the participants in each review or visit
- Includes meeting agendas and minutes
- Reports all items discussed
- Identifies discrepancies noted and reports on corrective action(s) taken or planned
- Identifies follow-up action items, due dates, and the responsible party
- Identifies items needing resolution and time constraints for resolution

Provide reports of design reviews and comment resolution processes within two Working Days of the completion of the review to CDOT.

3.4.4 Quality Reporting

The QMP shall outline a reporting process for recording, organizing, and distributing a record of internal Quality activities. Quality reports shall be issued by the Quality Control Administrator (QCA) and be distributed to the Contractor's and CDOT's management personnel. The reports shall be prepared and submitted monthly. The reports shall include the following:

1. A summary of internal Quality activities
2. A summary of the status of all RFIs
3. A summary of the status of all NDCs and FDCs
4. A summary of the status of all non-conformances
5. A summary of any corrective and preventative actions

3.5 Design Quality

The QMP shall include a Design Quality Management Plan (DQMP) to describe specific procedures to be followed to ensure all the designs conform to the requirements of the Contract and to the design documents being used as the basis of construction.

The Contractor's DQMP shall include two primary elements; Design Process Quality Control and Independent Quality Control and Audits.

3.5.1 Design Process Quality Control

Design Process Quality Control shall include the following activities:

- Quality control checking of design calculations
- Quality control checking by discipline of milestone design packages (Preliminary Design Documents, RFC Documents, Final Design Documents and As-Built Documents)
- Quality control reviews of studies, reports & other design supporting documents
- Interdisciplinary reviews of milestone design packages (including regulatory compliance)
- Constructability reviews of milestone design packages
- Design software validation

All Design Process Quality Control activities shall be well defined in the DQMP and shall be fully documented processes.

3.5.2 Independent Design Quality Control and Audits

Independent Quality Control Audits shall include the following activities:

- Audits of all the Design Quality Control Processes related to the release of each specific design milestone package shall be performed and documented to assure its quality prior to the final release of the document. Audits will be performed by the Design Quality Manager and reviewed and approved by the Quality Control Administrator.
- Independent Technical Reviews
- Independent Structure Reviews where required by the Technical Requirements, or the Approved DQMP.

3.5.3 CDOT Design Acceptance

Ultimately CDOT Design Acceptance will be through the Acceptance of the Final Design Documents. To facilitate the Acceptance of the Final Design Documents CDOT will perform in-progress acceptance activities, including:

- Monitoring the adequacy of the DQMP.
- "Over-the-Shoulder" in progress design reviews
- Formal design reviews of milestone design packages
- Auditing the resolution of design review comments through Comment Resolution Forms.

3.5.4 Preliminary Design Plans

The Contractor shall prepare Preliminary Plans (at approximately 30% design completion) showing how the Contractor's design meets the Basic Configuration requirements and submit to CDOT for Review a minimum of 14 Days, excluding holidays, prior to the review meeting. CDOT Review of the Preliminary Plans will not relieve the Contractor from compliance with any of the project design requirements that may not be adequately or addressed or are incorrectly addressed in the Preliminary Plans. The Preliminary Plans shall include a cover sheet, typical sections, highway ramp and street plans and profiles, bridge and major drainage structures general layouts, master drainage plan, preliminary retaining wall and noise wall layouts and roadway cross sections at 200 foot intervals.

3.5.5 Released For Construction (RFC) Documents

Released for Construction Documents allow the Contractor to initiate construction in advance of Acceptance of the Final Design Documents by CDOT. The RFC Documents shall include plan quantities to bid level accuracy. The RFC Documents shall include a Materials Testing and Inspection Plan (MTIP). This plan will give testing quantities and frequencies, and applicable inspection hold points from the QMP. The Contractor's Quality Control Administrator shall approve RFC Documents prior to release for construction.

The QMP will identify the procedure for which RFC documents are released for construction including a discussion of the specific roles of the Contractor's Project Manager, QCA, DQM, CQM, and Design Manager.

The QMP shall identify a specific process to provide for the review of the RFC documents by CDOT and any other agencies that will ultimately have Acceptance or Approval authority for the Work and the Final Design Documents. RFC Documents shall be initially submitted to CDOT as Pre-RFC Review Documents, a minimum of 14 Days, excluding holidays, prior to the review meeting. The Review process will include a comment resolution process for documenting all review comments affecting the RFC Documents and their resolution prior to submittal of Final RFC Documents to CDOT. The DQM shall provide documented assurance that all comments have been resolved with the submittal of the Final RFC Documents. CDOT will review the Final RFC Documents and respond to the Contractor within 3 working days of their submittal with Acceptance or a requirement to resubmit the documents with resolution to specifically stated deficiencies.

CDOT's Acceptance of partial designs within RFC Documents will not constitute Acceptance of the overall design or subsequent construction nor relieve the Contractor of its responsibility to meet the Contract requirements. Irrespective of whether CDOT provides the Contractor with the

authority to begin construction on elements of the Project prior to completion of the entire design, the Contractor shall bear the responsibility to ensure that construction meets the requirements of the Contract Documents, applicable law, and the governmental approvals.

The QMP shall include a process for a Colorado registered Professional Engineer(s) in responsible charge for the design to review and approve and seal all Final RFC Documents prior to their issuance and review and approve and seal revisions to previously released for construction documents.

3.5.6 Design Changes after Plans have been Released for Construction

The QMP will outline the design, review, and approval method for issuing Notice of Design Changes (NDC) or Field Design Changes (FDC) after plans have been released for construction. Design changes are new or revised items of work that were not included in original RFC Documents. NDCs and FDCs must go through a formal and documented design review process. All NDCs and FDCs shall be approved by the Engineer(s) in Responsible charge of the original design(s).

The QMP shall include a process to propose, notify, receive, track, respond to, and distribute design changes, and the participants and their associated responsibilities, and a work process for each change. The ICQC Team shall review all design changes. The Contractor shall invite CDOT to all reviews. The ICQC Team, in coordination with CDOT, will jointly determine the procedures and timing of reviews, with the mutual understanding that a timely and expeditious design change process benefits all parties, balanced with the quality of the end product. CDOT Acceptance will be required for all NDC documents, prior to release for construction.

3.5.7 Working Shop and Falsework Drawings

The Contractor shall outline the process in the QMP for how shop drawings and falsework are prepared, reviewed, and corrected. The process outline shall include:

- Personnel assigned to perform construction submittal reviews
- Procedures for documenting reviews and approvals and for obtaining corrective action

3.5.8 Final Design Documents

The Contractor shall submit Final Design Documents to CDOT for Acceptance. CDOT will not Accept the Final Design Documents until the Contractor has completed all design and has addressed, resolved, and incorporated, to the satisfaction of CDOT, any prior Contractor, ICQC, third party and CDOT Acceptance review comments. The Contractor shall ensure and provide documentation to CDOT that all review comments have been addressed. If deemed necessary by CDOT, the Contractor shall resubmit revised Final Design Documents until such time that CDOT determines that the review comments have been satisfactorily addressed. The Final Design Documents submittal shall include, as a minimum:

1. All design plans.
2. Design calculations.
3. Design reports.
4. Specifications.

E. Estimated quantities.

F. CADD files as specified elsewhere in the Contract Documents.

3.5.9 As-Built Documents

As-Built Documents shall be submitted to CDOT for Acceptance. CDOT may assess As-Built Documents to ensure completeness and compliance with the requirements of the Contract. CDOT shall not Accept As-Built Documents until the Contractor has adequately addressed any prior Contractor PC reviews, ICQC audits or CDOT assessments/testing. The Contractor shall provide documentation to CDOT that all have been addressed. The As-Built Documents submittal shall include:

1. All plans reflecting Released for Construction Documents and any revisions to Released for Construction Documents
2. Resolution of prior Contractor ICQC audits or CDOT audits including completed Comment Resolution Forms demonstrating that all formal meeting review comments have been fully addressed through the design and construction of the project.
3. Design calculations
4. Design reports
5. Specifications
6. CADD files, as specified elsewhere in the Contract

3.5.10 Design Coordination

The QMP shall describe how the design team schedules design efforts, including but not limited to task force meetings, design reviews, constructability reviews, design meetings, independent design checks, and a schedule for Released for Construction, Final Design and As-Built Documents.

The Contractor's Engineer shall conduct weekly task force meetings to coordinate the design development within the Contractor's organizations, CDOT and other affected agencies. As a minimum, the Contractor shall prepare an agenda and conduct each meeting to discuss the status of the design, coordinate the design development between design disciplines, discuss constructability issues, and identify any questions associated with design requirements. The Contractor shall take meeting minutes for all task force meetings and provide minutes to CDOT within five Working Days after each meeting.

The Contractor shall hold joint design milestone review meetings for the Preliminary Design Plans, RFC Documents, NDC Plans, Final Design Plans and other milestone reviews deemed appropriate by the Contractor or requested by CDOT. The design progress meetings shall be scheduled, conducted, and documented by the Contractor. The meetings minutes shall be taken by the Contractor and submitted to CDOT within five Working Days after each meeting. The Contractor shall provide review documents stamped "Checked and Ready for Review,"

The DQM shall keep CDOT updated on the schedule of all upcoming milestone reviews at least two months in advance of review meetings. Milestone review meetings will not be scheduled within intervals of less than five working days, unless otherwise approved by CDOT.

3.6 Construction

The Contractor shall be responsible for performing and documenting all required construction Process Control and ICQC activities necessary to control the Work, which shall be documented in within the QMP as the Construction Quality Management Plan (CQMP). The CQMP shall cover both permanent and temporary Work (erosion control, traffic control, etc.). The CQMP shall describe specific procedures to be followed to provide assurance that all the Work conforms to all the requirements of the Contract and of the Design Documents being used as the basis of construction, and that all materials, equipment, and elements of the Work being incorporated in the Project will perform satisfactorily for the purpose intended. The CQMP will specifically include the procedures for inspecting, sampling, testing, checking, and documenting the Work including all Work performed by Subcontractors, and for distribution of information (e.g. Released for Construction Plans, design changes, Non-conformance Report (NCR) remediation, etc.) to all necessary parties.

The CQMP shall include provisions to ensure the quality and safety of Safety Critical Work in compliance the Special Provision “Revision of Section 107 – Performance of Safety Critical Work”, included in this Section.

3.6.1 Construction Process Control

The Contractor shall establish, document, and implement a Process Control Plan. The Process Control Plan shall include all procedures necessary for the Contractor to control the quality of its production processes to meet the requirements of the Contract. The Contractor shall develop a testing and inspection schedule to control the production processes.

Tests or inspections performed by production or Process Control (PC) personnel as part of the Quality Management Plan shall not be used to satisfy the ICQC requirements (Defined as Quality Assurance in the CDOT Field Materials Manual). All PC personnel shall be capable of performing all tests (both in the field and in the lab). The Contractor shall have the sufficient qualified personnel to respond to the workload. The Contractor shall provide the equipment/facilities to perform all tests. All testing personnel shall be properly certified. The PC labs shall be certified and on the AMRL accredited list.

PC staff shall:

- Be responsible for Quality of the Work during production.
- Be independent of the ICQC staff.
- Have authority to stop Work.

The CQMP shall include PC checklists. The PC checklists shall be developed and maintained by the Contractor at the Project Site and organized for execution of Work Breakdown Structure Activities and all other associated Contract requirements. The PC checklists shall be available for CDOT personnel review at all times. Unmaintained or not up-to-date PC checklists will constitute immediate Nonconforming Work. Work shall not proceed until the PC checklist is updated and made compliant to the requirements herein. The Contractor shall use current CDOT forms, manuals and handbooks to develop PC checklists.

3.6.2 Independent Contractor Quality Control (ICQC)

The Contractor shall be responsible to establish, document, and implement an Independent Contractor Quality Control (ICQC) program. The ICQC program will include both testing and inspection to support CDOT's Owner Acceptance responsibilities. The ICQC testing program shall satisfy all of the testing requirements defined as Quality Assurance in the CDOT Field Materials Manual. The Contractor shall include in the CQMP the methods and procedures by which the Work will be certified by the Contractor as complying with the requirements of the Contract.

ICQC personnel shall not participate in any Process Control activities and shall be independent of the Process Control personnel.

The Contractor's Quality Control Administrator shall document formal reviews to verify that the CQMP is being effectively implemented.

3.6.2.1 ICQC Inspection and Testing Staffing

The Contractor shall identify in the CQMP all necessary resources and personnel to perform all ICQC activities required to ensure all the Work meets the Contract requirements. The CQMP shall include a detailed staffing plan that identifies specific testing and inspection personnel commitments over the duration of the project that is consistent with the Contractor's baseline schedule. The staffing plan will constitute contractual staffing commitments and any changes of the staffing plan will be subject to CDOT Approval.

At a minimum the Contractor shall provide full time inspection personnel for the following construction operations:

- Major structural work (bridges, retaining walls and overhead sign structures)
- trenching work
- Minor structures work (box culverts, pipes and special drainage structures)
- Embankment operations
- Structure excavation and backfill operations
- Safety critical work
- Utilities relocation work
- ITS and electrical work
- Traffic control implementations
- Roadway base construction
- Paving operations
- During development of punch list and completion of punch list items

When work activities requiring full time inspection personnel are being performed simultaneously at different locations then each operation will require a separate full time inspector unless otherwise approved by CDOT.

3.6.2.2 Materials Testing & Inspection Plan (MTIP)

The Contractor shall prepare and implement a Materials Testing & Inspection Plan (MTIP) as part of the Approved QMP that includes the appropriate criteria, tests, and inspection requirements identified in CDOT's *Construction Manual, Field Materials Manual*, and Standard

Specifications. The MTIP shall include Contractor-developed inspection checklists of requirements as set forth herein.

The MTIP shall identify all inspections and tests required including, at a minimum, reference to the requirements of the Contract, frequency of the inspections and tests, and the Contractor-developed ICQC processes. Where no inspections or test standard exists in any of the CDOT manuals, the MTIP shall develop criteria based upon the best-available industry standard information and technology.

The MTIP shall include a summary of Activity-specific Material Quantities to document that the minimum sampling, testing, and inspection requirements have been met. This summary shall be performed and provided to the Department for Acceptance monthly. (The Contractor may follow the CDOT Form 250 as a minimum basis for their Materials documentation record.)

The MTIP shall include processes to control, calibrate, and maintain test equipment (both field and lab equipment), to ensure it meets industry standards and other applicable requirements. Test equipment used by the Contractor shall be of a quality and capacity that ensures that measurements made are to levels of accuracy and precision that are required by the test procedure.

The MTIP shall include procedures for delivery, handling, and storage of furnished products ensuring they are properly handled and stored to prevent damage, deterioration, or theft.

The MTIP will include the following elements:

1. Inspection: The MTIP that shall include detailed inspection procedures to be used in cases where inspections are to serve as the basis for verifying compliance with the requirements of the Contract. The Contractor shall conduct each inspection in accordance with the Approved QMP. The Contractor shall document whether the inspections passed or failed based on the “pass/fail criteria” established in the procedure and the requirements of the Contract; (e.g., concrete depth checks on deck pours, rebar clearance/size, locations, elevations, stationing etc.). The Contractor shall include failing inspection results in the inspection documentation.

2. Testing: At a minimum, the Contractor shall follow the CDOT *Field Materials Manual* and its Frequency Guide Schedule for Minimum Materials Sampling, Testing, and Inspection requirements identified under the column titled “Project Verification Sampling & Testing Frequency” for all Quality Assurance tests required and recorded on the associated CDOT standard forms.

   The Contractor shall document the results and show if the test passed or failed based on the "pass/fail criteria" established in the Contract. The Contractor shall include failing tests results in the test documentation.

   Independent Laboratories shall submit signed and certified test reports to the Contractor not more than 14 Working Days after completion of the tests for all tests which require an independent Laboratory.

CDOT reserves the right to witness any test conducted for Owner Acceptance purposes. The Contractor shall develop and maintain a current Test log for all tests required by the Contract.

As a minimum, the Contractor shall document results of tests in report format. Include the following:

- Contract or project identification number
- Identification of items tested
- Quantity
- Date and time test conducted
- Location of items tested
- Test procedure used
- Name of technician
- Acceptance criteria
- Results - acceptance or rejection
- Authorized signature

The Contractor shall provide a materials testing field laboratory (Class 2) for the MTT's and a certified full service geotechnical laboratory for more specialized testing, if required, that has been pre-certified by CDOT. Laboratories performing ICQC testing shall be independent from the PC laboratories.

3.6.2.3 Product Control Plan (PCP)

The PCP shall include procedures for the Contractor to inspect and test, where applicable, procured products provided by Suppliers during the manufacturing, receiving, and installation processes to ensure the requirements of the Contract documents are met. This work includes ICQC activities at manufacturing and fabrication sites that would typically be provided by CDOT on a traditional design-bid-build delivery.

The PCP shall require the Contractor to maintain receiving inspection procedures. CDOT may designate hold points in the manufacturing and installation process.

The PCP shall include procedures to document and demonstrate product compliance with requirements of the Contract documents by Certificates of Compliance (COC) or Certified Test Reports (CTRs). The Contractor shall obtain COCs / CTRs prior to incorporation in the Work and before inclusion on the monthly invoice, and maintain a complete log of all COCs and CTRs. The log and all COCs / CTRs shall be available for CDOT's Verification at any time. The Contractor shall include in the COC/CTR log, signed certification that all Materials represented by each COC/CTR was installed in the Work. Certification shall be according to requirements of the Contract. The Contractor shall submit all COCs/CTRs to CDOT prior to Final Acceptance.

The PCP shall include procedures for delivery, handling, and storage of furnished products ensuring that they are properly handled and stored to prevent damage, deterioration, or theft. The PCP shall document procedures for stored items and Materials consistent with the expected duration and type of storage.

The PCP shall include procedures for monitoring special processes utilized in fabrication, assembly, and testing of specified products. Special processes are those requiring qualified/certified production, inspection, and test personnel to perform highly skilled Work such as welding, brazing, soldering, non-destructive testing, machining, coating, or plating.

3.6.2.4 Specialized Manufacturing Facilities

Specialized manufacturing facilities may be required to supply items or materials not typically specified by CDOT. The QMP shall specify how the Contractor will ensure that specialized manufacturing facilities meet requirements established by CDOT. These requirements include but are not limited to the following:

- How manufacturing facilities will be selected.
- How the Contractor, the ICQC Team, and CDOT will determine the inspection requirements of the facility (i.e. initial capabilities of the facility, ongoing process and production, final product certification and documentation, delivery and handling processes etc.).
- The lead times required for on-site inspection of the facilities. CDOT requires a 30-day lead time to make travel arrangements for facility capability inspection.

Sampling and testing requirements of final product

3.6.2.5 Hold Point Inspection

A Hold Point is a point in time when construction has proceeded to a defined stage and at which representatives of the Contractor's production, PC, and ICQC staff, determine the conformance of the Work to that point. The Contractor shall invite CDOT to all Hold Point inspections, with notice of each Hold Point Inspection provided 24 hours in advance.

With the exception of corrective work items, no additional Work may take place past the Hold Point until the Work conforms to the requirements of the Contract and CDOT has formally authorized continuance of the Work.

The QMP will identify construction Hold Points, subject to CDOT Approval. At a minimum the following Hold Points that shall be established:

<u>Environmental Mitigation Measures</u>

A. Before any construction occurs, and after implementation of Best Management Practices (BMPs) and environmental controls per the Permitting requirement
B. Prior to disturbing any stream, dewatering, diverting watercourses, or building cofferdams

<u>Embankments</u>

A. After completion of drainage and utility installations, and before backfill
B. After all clearing, grubbing, and excavation
C. After each lift in accordance with specifications for lift requirements (applicable to all embankments, including walls)
D. After completion of MSE wall panel placement every 10 vertical feet

E. At completion of embankment placement
F. At completion of surcharge placement
G. Prior to removal of surcharge

Structures

A. Before placement of the leveling pad of an MSE wall or other type of retaining wall
B. At completion of bridge embankment settlement
C. Before start of bridge foundation pile-driving
D. At Contractor's ICQC approval of pile driving submittals (including design calculations, wave analysis, and hammer specification)
E. After completion of pile-driving at each structure support (pile group), including pile-driving results and records
F. Before concrete placement of any substructure element, including pile infilling and drilled shafts
G. Before and after girder and diaphragm placement
H. Before concrete placement of deck, approach slabs, diaphragms, and parapets
I. Before concrete placement of cast-in-place (CIP) retaining walls and box culverts; after rebar placement but before final form placement for CIP retaining walls and box culverts taller than 6 feet

Surfacing, Paving, and Concrete

A. Before placement of each course above sub-grade on permanent roadway components (granular borrow, lean base, etc.)
B. Before placement of each lift of asphalt or PCC paving on permanent roadway components
C. Before any placement of concrete
D. Every 1,000 feet of slip-form barrier

Noise Walls

A. After completion of every 500 feet of noise wall posts or panels

Traffic Devices and Switches

A. Before opening to traffic

ATMS

A. Before backfilling trenches containing conduit

B. Before placing flowable fill around junction boxes

The QMP shall specify processes for monitoring the progression of Work, including associated quantities of materials, through the tracking of Hold Points. The process should be designed to aid in progressing Work, verifying payments, and avoiding duplicate inspection, testing, and reporting.

CDOT and/or the Contractor may identify additional Hold Points to be included at any time during the Project. CDOT and the ICQC Team will coordinate to define the procedures and criteria for additional Hold Points. The QMP shall include any additional Hold Points identified and necessitated by the Contractor's specific design and construction approaches.

3.6.2.6 Specific Inspection Procedures

Deep Foundations

The QMP shall detail the Contractor's process for monitoring and inspecting all elements of the Work required by the Contract related to drilled shafts, driven piles, and micropiles.

Paving Quality

The Contractor shall provide the following paving quality procedures in the QMP and submit a paving quality plan 30 days prior to the beginning of paving operations for Approval by CDOT, including:

1. A thorough definition of pavement smoothness and quality, which shall be the same for all travel lanes and shoulders, and the identification of steps for maintaining smoothness criteria, including defined hold points and potential corrective measures.
2. Detailed procedures for identification of potential issues affecting pavement quality such as smoothness, dumping and batching.
3. Procedures for monitoring and minimizing and correcting for lane to lane roughness variation.
4. Procedures for dowel bar and tiebar placement and MIT testing and inspection, including the Contractor's obligation to provide additional test sections for MIT testing and auditing at CDOT's discretion in the event that all or part of the Work is suspended due to dowel bar placement non-conformances.
5. A PCCP quality recovery plan for paving quality issues with corrective and preventative measures.

3.6.2.7 Nonconforming Work

The Contractor shall include in the QMP procedures to develop and maintain a system to identify, control, remedy and report Nonconforming Work, including Nonconforming Work identified by CDOT. The QMP shall include procedures to identify Nonconforming Work and to withhold progress payment requests on the monthly Invoice until the Nonconforming Work is remedied. The Contractor shall remedy Nonconforming Work in accordance with the QMP. The responsibility for review and for the disposition of Nonconforming Work shall be established in the QMP. The Contractor shall identify Nonconforming Work by completing a Nonconformance Report (NCR). A NCR shall include:

1. Identification of Nonconforming Work, including tagging Work products and location
2. Description and evaluation of the Nonconforming Work
3. Applicable Contract requirements
4. Cause of Nonconforming Work
5. Recommendation for " remove and replace", "repair" or "use as is" dispositions
6. Cost adjustment recommendations (if applicable)

7. Cause of Nonconforming Work
8. Proposed corrective action to prevent recurrence
9. Responsibility for accomplishing corrective action
10. Schedule of Work with a date of remedy completion
11. Signature lines for the Engineer in Responsible Charge, Quality Control Administrator and CDOT verifying that the Nonconforming Work recommended remedy has been approved.

The recommended remedy for the Nonconforming Work shall be approved by the Engineer in Responsible Charge and the Quality Control Administrator prior to its submittal to CDOT. The Contactor shall not perform the recommended remedy prior to receiving from CDOT a determination of “repair” and “use as is” dispositions. For “repair” and “use as is” dispositions NCR Report shall clearly identify if and how the remedy is out of compliance with the Contract requirement and why its nonconforming use is acceptable.

The Contractor shall develop and maintain a Nonconforming Work log to track and identify the status of Nonconforming Work. An updated log shall be submitted to CDOT weekly and shall be used by the Contractor to look for Nonconforming work trends to determine if corrective actions are needed.

The Contractor shall include in the QMP procedures for controlling the use of Nonconforming Work including the tagging of Nonconforming Work products. Nonconforming Work product tags shall only be removed by the originator of the NCR or the originator’s supervisor, and only when the Contractor demonstrates to CDOT that the Nonconforming Work product meets the requirements of the Contract.

All NCRs shall be recorded by the Contractor and provided to CDOT. The Quality Control Administrator will maintain a log of all NCRs and submit it weekly to CDOT. Each NCR shall be numbered sequentially and provide a brief description and status.

As a part of its verification and acceptance activities CDOT will perform assessments, which may result in CDOT issued NCRs. These efforts are completely independent of Contractor ICQC activities and not relieve the Contractor of Quality inspection and testing responsibilities. CDOT will forward all assessment reports and Nonconformance Notices (NCN) to the Contractor and the Contractor shall respond to all NCNs five Working Days of issuance. The Contractor’s response shall identify how it proposes to remedy the Nonconforming Work and the date by which the remedy shall be completed. The QMP shall describe the approach and methodology for resolving CDOT NCNs.

3.6.2.8 Corrective and Preventative Action

The QMP shall describe corrective and preventative action procedures that the Contractor shall use to identify and improve processes that produce, or may produce, systemic Nonconforming Work identified by the Contractor or by CDOT. The Contractor’s corrective and preventative action procedures shall include:

1. Methods to investigate the cause of systemic Nonconforming Work and to determine what corrective action is needed to prevent recurrence

2. Methods to analyze all processes, Work operations, quality records, service reports, and CDOT assessments/testing to detect and eliminate the possibility of systemic Nonconforming Work from occurring
3. Methods to prioritize corrective and preventive action efforts based upon the level of risk to the quality of the Work
4. Controls to ensure that effective corrective and preventative actions are taken when the need is identified
5. Methods to implement and record changes in procedures resulting from corrective and preventative actions

3.6.3 Operational Quality Control

The Contractor shall establish, document, and implement an Operational Control Plan. The Operational Control Plan shall include all procedures necessary for the Contractor to control the quality operations that support the construction of the Project, including:

- Environmental Compliance Plan
- Maintenance of Traffic Operations
- Construction Water Quality
- Public Relations

3.7 CDOT Owner Verification and Owner Acceptance Activities

CDOT's Owner Verification will use a testing and workmanship assessment sampling approach to assess the Contractor's compliance with the requirements of the Contract Documents.

CDOT will:

- Perform quality oversight audits and reviews
- Monitor and audit the Contractor's quality program processes to verify adherence to the QMP
- Participate in pre-activity meetings, Hold Point inspections, on-site meetings, and plan and specification reviews
- Participate in Contractor initiated training
- Audit the Project records
- Conduct verification and testing (oversight, sampling, inspection, and evaluation).
- Conduct Independent Assurance Testing
- Perform off-site verification inspection and testing of the fabrication of precast and pre-stressed concrete structures and of structural steel
- Issue Final Acceptance of the Work

CDOT retains the right to stop Work:

- If there is evidence that the QMP procedures are not being followed, or if the design, materials, or workmanship are not meeting the Contract requirements, CDOT may, at its sole discretion, stop Work until corrective procedures have been established and implemented.

- If the Contractor fails to correct conditions that are unsafe for Project personnel and/or the general public.

CDOT reserves the right to:

- Check testing equipment for compliance with specified standards and to check testing procedures and techniques.
- Access the testing facilities of independent testing agencies to witness testing and verify compliance of testing procedures, testing techniques, tester certifications, and test results.

CDOT has the authority to remove any of the following from the Project:

- A tester who does not perform testing in accordance with the test methods
- A tester who does not report test results accurately
- An inspector who does not exercise good judgment in the performance of duty or demonstrates incongruity with respect to the contract
- A tester who is not certified

3.7.1 Owner Verification Testing

CDOT, or its representative, will perform Owner Verification Testing (OVT). OVT encompasses material sampling and testing, the results of which are used to validate the ICQC Team's testing efforts. The OVT tests will be conducted at approximately 10 percent of the frequency of the ICQC testing performed by the ICQC Team. Based on a successful verification by the OVT effort, the ICQC tests will be incorporated into the acceptance decision. The verification evaluation may include statistical comparison and validation of test results (e.g., F&T test, control charts, etc.), monitoring quality processes of the ICQC Team, and limited over-the-shoulder review of test procedures and processes where appropriate.

In accordance with 23 CFR 637.207 CDOT will establish a dispute resolution system to address the resolution of discrepancies occurring between the verification sampling and testing and the quality control sampling and testing. This dispute resolution system may be administered entirely within the CDOT.

3.7.2 Independent Assurance Roles and Responsibilities

CDOT will perform independent assurance reviews and tests to ensure that:

1. Contractor ICQC personnel are trained and certified and demonstrate that they understand the test procedures they are performing.
2. The test equipment used by the Contractor's ICQC personnel is calibrated.
3. Split sample test results correlate.
4. The facilities used are AMRL certified

Independent assurance test results will also be used as referee tests to assess statistically significant differences, determined by CDOT in its sole discretion, between Contractor ICQC tests and CDOT Verification test results.

3.7.3 Third Party Owner Inspections and Approvals

Third party personnel shall have the right to inspect the Work, provided that the third party has jurisdiction over the Work and as required by Applicable Law. The Contractor shall adhere to third party inspection and approval procedure.

3.8 Final Inspection

The Contractor shall develop a process, within the QMP, for scheduling, accomplishing, and tracking the final inspection process and developing and resolving punch-lists in conformance with the requirements in Section 20 of Book 1. Final inspection will include inspection of the Work by the Contractor and ICQC/ PC, and associated As-Built documents, certifications, and Contractor cleanup requirements.

Contractor ICQC and PC personnel shall perform an independent inspection of all Work and address any outstanding and/or nonconforming work prior to requesting an inspection from CDOT. After the inspection, CDOT, ICQC Team, and Process Control Staff will jointly agree upon punch-list items and an agreed date of correction of the items. The punch-list and punch-list log shall be completed by Process Control and ICQC personnel and be provided to CDOT for information. Contractor shall invite CDOT, including CDOT Maintenance, and other affected agencies to attend the independent inspections of the Work to include items on the punch-list and CDOT will attend at its sole discretion.

CDOT will perform a final field audit of the Work with ICQC/PC personnel after the Contractor has resolved its final punch list, and ICQC has provided its final acceptance of the work. CDOT's final inspection will be performed prior to Final Acceptance of the Project in accordance with Section 20.1.4 of Book 1.

3.9 Environmental Monitoring and Compliance

The Contractor's Operational Quality Control Plan shall describe the methods, processes, and procedures to provide for the effective implementation and documentation of the environmental protection, training, compliance, and monitoring program. Refer to Section 5, Environmental for additional requirements.

3.10 Deliverable Requirements

3.10.1 Quality Management Plan

The Contractor shall submit the QMP as identified in Section 3.1, Administrative Requirements.

3.10.2 Design Deliverables

The Contractor shall submit all design deliverables to CDOT for review including the QMP, work plans, design reports and studies, Released for Construction (RFC) Documents, Notice of Design Change (NDC) and Field Design Change (FDC), Final Design Documents, and As-Built Documents. Review documents shall be submitted to CDOT a minimum of 14 Days, excluding holidays, prior to review meetings, unless otherwise specified in the Contract documents. The review process will include a comment resolution process for documenting all review

comments and their resolution. The DQM shall provide assurance that all comments have been resolved prior to final submittal of all documents that require CDOT's Acceptance or Approval.

The Contractor shall identify on its Contract Schedules when design deliverables will be submitted to CDOT.

The Contractor shall provide two hard copies (11 x17 inches for plans, 8.5 x 11 inches for specifications), and one set of electronic files on compatible electronic media of the design deliverables to CDOT.

As-Built Documents shall show all changes. All changes shall be noted using CADD. Hand-drawn changes will not be allowed.

The design deliverables shall be delivered to CDOT indexed and clearly marked to indicate the date of issue and stage of development. All design deliverables shall include a title block, consistent with the standard project drawing format established as part of the QMP, with the following information:

1. Date of issuance and including all prior revision dates
2. Contract title and number
3. Subject identification by Contractor drawing or Contract reference

All RFC, NDC and FDC documents shall be sealed by the Engineer (s) in Responsible Charge,

If a design deliverable requires review and approval from a Local Agency or permitting authority, the Contractor shall gain such concurrence prior to submitting the design deliverable to CDOT.

Specifications applicable to a design deliverable shall be submitted with the design deliverable.

The CADD drawings and associated documents shall be organized in a logical manner, have a uniform and consistent appearance, and clearly depict the intent of the design and construction. In addition:

1. The software requirements for all submitted design deliverables shall be InRoads/Microstation, in accordance with the current CDOT standards in effect at the time of Proposal submittal by the Contractor.
2. Project files shall be organized and submitted in accordance with CDOT's ProjectWise format.
3. All design deliverables shall be in English units. The Project coordinate system shall comply with the CDOT *Survey Manual*.
4. The Contractor shall prepare RFC, NDC FDC and As-Built Documents for the Project that shall include as applicable the following: following:

    1) Title Sheet
    2) Index
    3) Standard Plan List
    4) Summary of Approximate Quantities
    5) Roadway Design Data

6) General Notes
7) Pavement Details
8) Roadway Details
9) Drainage Details
10) Geotechnical Plans
11) Environmental Mitigation, as necessary
12) Permanent Signing Plans
13) Traffic Signal Plans
14) Aesthetic Elements
15) Roadway Typical Sections
16) Roadway Geometric Layout Plans
17) Roadway Geometric Layout Tables
18) Roadway Plan
19) Roadway Profile
20) Construction and Phasing and Traffic Control Plans
21) Intersection Plans
22) Bike Path Plan and Profile
23) Pavement Plans
24) Drainage Plans
25) Pavement Marking Plans
26) Utility Plans
27) ITS Plans
28) Landscape/Seeding Plans
29) Grading Plans
30) Lighting Plans
31) Bridge Plans
32) Wall Plans
33) Park Plans
34) Other Details, as needed
35) Specifications

The Contractor shall provide one set each of electronic files on compatible electronic media of Utility As-Built Documents to CDOT and to the respective Utility Owner(s) for Utility Work constructed by the Contractor, that conform to the project CADD requirements, except as modified by the specific requirements of the individual Utility Owners. The Contractor shall obtain from each Utility Owner performing its own construction; one set of Utility As-Built Documents for their Utility Work and shall show the information on the As-Built Documents.

All As-Built Documents electronic files shall be submitted in *.dgn and *.pdf format.

All CADD files shall be documented in a tabular format describing the path, file name, and description.

3.10.3 Document and Data Approval

The Contractor shall ensure that all deliverables include a signed and dated certification by the originator of the deliverables and that the deliverable is complete and meets the requirements of the Contract.

3.10.4 Document and Data Changes

The Contractor shall ensure that any changes to deliverables provided to CDOT as revised are in a format that can enable changes to be readily apparent and trackable (e.g., documents use the redline/strikeout method).

3.10.5 Product Data

The Contractor shall submit to CDOT for Acceptance two hard copies of all manufacturers' warranties, guarantees, instruction sheets, parts lists, and other product data within 20 Days of installation of the items to which they relate. The Contractor shall ensure that the product data cited is organized and indexed in a manner that allows easy retrieval of information.

3.10.6 Submittals

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

Deliverable	Review, Acceptance, or Approval	Schedule
Quality Management Plan	Approval	For design related Work, prior to issuance of NTP1. The entire QMP for all remaining Work on the Project must have CDOT's Approval before NTP2
Meeting Minutes (defined in QMP)	Review	5 Working Days after meeting
Task force Meeting Minutes	Review	5 Working Days after meeting
Design Progress Meeting Minutes	Review	5 Working Days after meeting
Quality Status Report	Review	Monthly
Summary of Activity-specific Materials Quantities, to support the MTIP	Acceptance	Monthly
Preliminary Design Plans (30%)	Review	Prior to submittal of RFC Documents and a minimum of 14 Days, excluding holidays, prior to the review meeting
Pre-Released for Construction (RFC) Review Documents	Review	Prior to submittal of Final RFC Documents and a minimum of 14 Days, excluding holidays, prior to the review meeting
Final RFC Documents	Acceptance	A minimum of 3 Working Days prior to construction of the applicable Work
Final Design Plans (100%)	Acceptance	After the completion of all design
Revisions to previously Released for Construction Documents, through Notice of Design Change (NDC) Documents	Acceptance	Prior to construction of the revised Work
ICQC inspections, test data and approved test results	Acceptance	Within 2 Working Days following inspection or test
Safety Critical Construction Plan	Review	2 week prior to the safety critical element conference.
As-Built Documents	Acceptance	Prior to final inspection of the Work
Nonconformance Reports and Work Log	Acceptance	Weekly
Two hard copies of all manufacturers' warranties, guarantees, instruction sheets, parts lists, and other product data	Acceptance	Within 20 Days of installation of the items to which they relate
COC/CTR Record	Acceptance	Prior to Final Acceptance

Final Materials Documentation and CDOT form 250 Materials Documentation Record	Acceptance	Prior to Final Acceptance

3.11 Project Special Provisions

The following specifications modify and take precedence over the Standard Specifications

3.11.1 Revision of Section 107, Performance of Safety Critical Work

Section 107 of the Standard Specifications is hereby revised as follows:

Add subsection 107.061 immediately following subsection 107.06 as follows:

107.061 Performance of Safety Critical Work. The following work elements are considered safety critical work for this project:

(1) Overhead girder and deck panel/form erection
(2) Overhead structure construction or repair including placement of concrete over or directly adjacent to live traffic lanes
(3) Removal of bridge
(4) Removal of portion of bridge
(5) Temporary works: falsework, shoring that exceeds 5 feet in height, cofferdams, and temporary bridges
(6) Work requiring the use of cranes or other heavy lifting equipment to set a girder, to make overhead repairs, erection of light standards, erection of overhead sign structures, caisson and pile construction, placement of temporary barrier adjacent to live traffic,, or includes special provisions for Removal of Bridge or Removal of Portion of Bridge. Also when construction materials are being lifted that may fall onto active traffic lanes.
~~(7) Blasting~~
(8) Excavation and embankment adjacent to the roadway, especially if it requires shoring.
~~(9) Tunneling~~
(10) Work operations such as pile driving and jack hammering which may create vibration and cause debris to fall into traffic.
~~(11) Rockfall mitigation~~
~~(12)~~ Any temporary or permanent structures over the highway

The Contractor shall submit, for record purposes only, an initial detailed construction plan that addresses safe construction of each of the safety critical elements. When the specifications already require an erection plan, a bridge removal plan, or a removal of portion of bridge plan, it shall be included as a part of this plan. The detailed construction plan shall be submitted two weeks prior to the safety critical element conference described below. The construction plan shall be stamped “Approved for Construction” and signed by the Contractor’s Engineer in Responsible Charge of construction or the Quality Control Administrator (QCA).

The Construction Plan shall include the following:

(1) Safety Critical Element for which the plan is being prepared and submitted.
(2) Contractor or subcontractor responsible for the plan preparation and the work.
(3) Schedule, procedures, equipment, and sequence of operations, that comply with the working hour limitations
(4) Temporary works required: falsework, bracing, shoring, etc.
(5) Additional actions that will be taken to ensure that the work will be performed safely.
(6) Names and qualifications of workers who will be in responsible charge of the work:
    A. Years of experience performing similar work
    B. Training taken in performing similar work
    C. Certifications earned in performing similar work
(7) Names and qualifications of workers operating cranes or other lifting equipment
    A. Years of experience performing similar work
    B. Training taken in performing similar work
    C. Certifications earned in performing similar work
(8) The construction plan shall address how the Contractor will handle contingencies such as:
    A. Unplanned events (storms, traffic accidents, etc.)
    B. Structural elements that don't fit or line up
    C. Work that cannot be completed in time for the roadway to be reopened to traffic
    D. Replacement of workers who don't perform the work safely
    E. Equipment failure
    F. Other potential difficulties inherent in the type of work being performed
(9) Name and qualifications of Contractor's person designated to determine and notify the Contractor's Engineer in Responsible Charge of construction in writing when it is safe to open a route to traffic after it has been closed for safety critical work.
(10) Erection plan or bridge removal plan when submitted as required elsewhere by the specifications. Plan requirements that overlap with above requirements may be submitted only once.

A safety critical element conference shall be held two weeks prior to beginning construction on each safety critical element. The Contractor, the safety critical element subcontractors, and the Contractor's Engineer in Responsible Charge of Construction or QCA shall attend the conference. Required pre-erection conferences or bridge removal conferences may be included as a part of this conference.

After the safety critical element conference, and prior to beginning work on the safety critical element, the Contractor shall submit a final construction plan to the Engineer for record purposes only. The Contractor's Engineer in Responsible Charge of construction, or QCA shall sign and seal temporary works, such as falsework, shoring etc., related to construction plans for the safety critical elements, (3) Removal of Bridge, (4) Removal of Portion of Bridge and (5) Temporary Works. The final construction plan shall be stamped "Approved for Construction" and signed by the Contractor's Engineer in Responsible Charge of Construction or QCA.

The Contractor shall perform safety critical work only when the Engineer is on the project site. The Contractor's Engineer in Responsible Charge of Construction or QCA shall be on site to inspect and provide written approval of safety critical work for which he provided signed and sealed construction details. Unless otherwise directed or approved, the Contractor's Engineer in Responsible Charge of Construction or QCA need not be on site during the actual performance of safety critical work, but shall be present to conduct inspection for written approval of the safety critical work.

When ordered by the Contractor's Engineer in Responsible Charge of Construction or QCA, the Contractor shall immediately stop safety critical work that is being performed in an unsafe manner or will result in an unsafe situation for the traveling public. Prior to stopping work, the Contractor shall make the situation safe for work stoppage. The Contractor shall submit an acceptable plan to correct the unsafe process before the Contractor's Engineer in Responsible Charge of Construction or QCA will authorize resumption of the work.

When ordered by the Contractor's Engineer in Responsible Charge of Construction or QCA, the Contractor shall remove workers from the project that are performing the safety critical work in a manner that creates an unsafe situation for the public in accordance with subsection 108.05.

Should an unplanned event occur or the safety critical operation deviate from the submitted plan, the Contractor shall immediately cease operations on the safety critical element, except for performing any work necessary to ensure worksite safety, and provide proper protection of the work and the traveling public. If the Contractor intends to modify the submitted plan, he shall submit a revised plan to the Contractor's Engineer in Responsible Charge of Construction or QCA prior to resuming operations.

All costs associated with the preparation and implementation of each safety critical element construction plan will not be measured and paid for separately, but shall be included in the work.

Nothing in the section shall be construed to relieve the Contractor from ultimate liability for unsafe or negligent acts or to be a waiver of the Colorado Governmental Immunity Act on behalf of the Department.

4.0 PUBLIC INFORMATION

Providing timely, relevant and context sensitive information is a critical component of the C-470 Express Lanes Project (C-470). The Contractor shall demonstrate a commitment to these values and to developing a communications approach that can reach the project's many diverse stakeholders during construction.

Anticipated communications issues on this project might include but are not limited to:

1. Noise mitigation
2. Night work
3. Access
4. Multimodal interests

CDOT has identified the Key Stakeholders listed below as audiences requiring coordinated outreach by CDOT and the Contractor. The Contractor shall describe in the Construction Communications Plan (CCP) its proposed approach to communicating with these Stakeholders and coordinating with CDOT. The Stakeholders include, but are not limited to:

1. Area businesses and business organizations
2. Denver Regional Council of Governments
3. All members of the C-470 Corridor Coalition
4. Bicycle Groups
    a. Bike Jeffco
    b. Bicycle Douglas County
5. Neighborhood Groups
    a. Highlands Ranch Community Association
    b. Highlands Ranch Neighborhood Coalition
    c. Others
6. Local, regional, and state government elected and appointed officials
    a. South Suburban Parks and Recreation District
    b. Highlands Ranch Metro District
7. Emergency response agencies, such as the Colorado State Patrol, local police, local fire departments, ambulance service providers, and hospitals.
8. Local tourism organizations
9. CDOT employees and other internal team members, including CDOT Headquarters, the Public Relations Office and the Government Relations Office
10. Regional Transportation District (RTD)
11. E-470 Authority
12. Utility owners
13. School districts
14. Union Pacific Railroad; Burlington Northern Santa Fe Railway
15. Other transportation construction projects in the area

Staff Requirements

The Contractor shall provide a full-time Public Communications Manager (PCM), with at least seven (7) years professional experience in Public/Media Relations, Marketing or other related

field acceptable to the Project Director and CDOT's C-470 Communications Manager. The PCM shall have exceptional writing skills and experience working with both print and broadcast media, as well as relevant transportation communications experience. The contractor shall submit the Project Communications Manager (PCM) and resume as part of the key project staff for Approval by CDOT. The PCM shall be responsible for overseeing all Contractor communications efforts during construction. The PCM shall be locally based over the term of the contract.

The Contractor shall submit the names and resumes of additional members of the Communications Team with assigned roles and responsibilities. As part of the Project Communications Team, the Contractor also shall provide a list of any specialists that will be a part of the Team.

The Communications Team shall be housed at the project office for the duration of construction.

Staff Coordination

The Contractor shall participate in weekly project meetings held at the project office. At the meetings, Contractor will discuss weekly communications issues and work with CDOT on program management and provide timely details for upcoming media advisories/press releases, lane closure reports, website updates and information line recordings.

The PCM shall be available or on call every working day and available upon request at other than normal working hours. The PCM shall maintain communications with CDOT regarding all aspects of public information related to this project.

4.1 Communications Plan

The Contractor shall prepare and maintain Communications Plans in coordination with CDOT to develop robust, two-way communications during each phase of the contract including:

- Construction Communications Plan
- Crisis Communications Plan

Each plan shall include project milestones and planned communications strategies; primary stakeholder communications list and outreach strategies; identification of any public information issues and proposed outreach. Each plan shall be submitted to CDOT for review and Approval prior to the start of each phase. The Contractor shall update each plan quarterly.

Each plan will acknowledge the basic roles and responsibilities between CDOT and the Contractor. In general:

CDOT Responsibilities: CDOT is responsible for communicating overall vision on the project including why the Project is needed, what work will be done, how the Project will benefit customers, how the Project fits into the community, and how the Project fits into broader transportation plans.

CDOT and the Contractor will provide the Project vision information to the public, as well as the related project details (phasing, traffic, impacts, etc.). All information that is made public must first be Approved by CDOT.

CDOT will be responsible for communicating overall implementation of Express Lanes and disseminate information provided by the Contractor to inform the public about any upcoming maintenance, operations issues, traffic impacts, major milestones, budget, etc. The Contractor shall work with CDOT to develop the messages and CDOT will have final Approval before the messages are disseminated

Contractor Responsibilities: The Contractor is responsible for communication overall coping information during construction including details about construction activities, detours, lane closures, closed ramps, access impacts, information resources available, Transportation Demand Management (TDM) strategies and other activities that affect residents and businesses during the life of the contract.

The Contractor is also responsible for supporting any communications related to the operations of the Express Lanes during the life of the contract. All information that is made public must first be Approved by CDOT's Communications Manager.

4.2 Construction Communications Plan

The Contractor shall prepare and maintain a Construction Communications Plan (CCP) in coordination with CDOT to develop two-way communication of Project information with the public. This CCP shall be used throughout the duration of primary construction project by the Contractor to manage and implement the public information process. The Contractor shall update the plan quarterly. The Contractor's final CCP shall be submitted to CDOT for Approval prior to the Notice to Proceed (NTP) 2.

The CCP shall include the following:

4.2.1 Public Information Approaches and Tools

The Contractor shall employ a variety of strategic and context sensitive public information approaches and public information tools to ensure that stakeholders have the necessary information about the project schedule, progress and construction information, as well as address issues as they arise.

Community/Business Relations

The Contractor shall develop and implement community and business relations strategies that communicate coping messages to the public. Coping strategies will focus on providing the public with the information they need to make short-term and long-term decisions about how they can deal with the work with as little disruption as possible. Each strategy will be uniquely tailored to individual stakeholder to include the location or region of customer group(s), when information is needed and when, tools to be used for dissemination such as one-on-one meetings, additional research, multi-lingual communications, providing regular calls or contact, etc. The stakeholders include, but are not limited to:

- Area residents
- Local and regional business owners, employees and customers
- Neighborhood associations
- Local community organizations
- Local schools
- Property owners and property management companies

- Commuters
- Transportation management/advocacy organizations
- RTD
- The traveling public
- Local, regional, and state government officials
- Delivery and courier services
- Taxis, shuttles, and rental car companies
- Commercial vehicle operators, Ports of Entry and Denver Permit Office, and Colorado Motor Carriers Association
- Emergency response agencies, such as the Colorado State Highway Patrol, and the local police departments, sheriff departments, fire departments, ambulance service providers, and hospitals
- Tourist destinations and organizations
- CDOT employees and other internal team members, including CDOT Headquarters, the Office of Communications and the Government Relations Office
- Disadvantaged Business Enterprise companies
- Utility owners
- Bicycle groups
- All members of the C-470 Corridor Coalition

Special consideration shall be given to the specific stakeholder communications including:

Bicycle, Pedestrian, Handicapped Mobility, Recreational and Other Access

The Contractor shall clearly define and communicate to the public and other associated stakeholder groups its plans for maintaining bicycle access, pedestrian access, recreational access and handicapped mobility.

Mass Transit Access

The Contractor shall work with RTD to clearly define and communicate to the public and other associated stakeholder groups its plans for maintaining access to bus and rail service.

Access to Local Schools

The Contractor shall work with the School Districts to define and communicate plans for maintaining bus and vehicle access.

Environmental Mitigation

In addition to the requirements of Section 5, Environmental Requirements, the Contractor shall coordinate any mitigation requirements, as they pertain to the public, with CDOT to ensure the public is aware of and participates in those areas where their input is required.

Noise

The Contractor shall communicate the scheduling of high noise events as well as temporary and permanent noise wall construction with individual property owners and impacted communities. The Contractor shall work with all impacted municipalities and individuals to comply with mitigation requirements.

Media Relations

During the Project, the Contractor shall immediately notify CDOT of any situations involving the media, and all communication requests will be tracked by CDOT. CDOT will handle all media inquiries and media requests unless otherwise requested. The Contractor shall write, as requested, media releases, traffic advisories and other information. CDOT will distribute per their standards. The Contractor shall be familiar with, and comply with, CDOT's required protocol when contacted by media representatives.

The Contractor shall make project managers, supervisors, and other area experts available for assistance in media requests. The Contractor shall also assist in media site visits and adhere to media deadlines when possible.

Government Relations

CDOT will develop and implement a comprehensive government relations program. The Contractor shall assist in giving timely information to CDOT regarding construction activities, and shall participate in meetings as requested.

Throughout the work, all communication requests received by the Contractor from government entities shall be immediately referred to CDOT (not including those requests related to project management or coordination for City permits, or related to the Contractor's responsibilities under the Contract Documents).

4.2.2 Public Information Outreach Tools

The Contractor shall provide a public information tool box with the flexibility to meet different stakeholder needs. The Contractor shall continue to coordinate with CDOT to ensure that the tools employed during the Project are effective. The need for language translation or interpretation should be evaluated by the Contractor.

Hotline

The Contractor shall establish a public information office equipped with a telephone, voicemail, computer and email address. The public information office may be located off-site or within the Contractor's field office, provided that the telephone line is a local call line. The voicemail greeting for the project information line shall be recorded in English and Spanish and provide an updated message each week, or each day if necessary, concerning the project's completion date and forthcoming activities on the project and allow the recording of a message from the caller. If unable to answer the public information line, the Contractor shall check and respond to voicemail messages throughout each day of construction operations and lane closures are being carried out. The Contractor shall track inquiries made by citizens and businesses, including names, addresses, phone numbers, and subsequent action taken during construction; these customer inquiries and follow-up action shall be entered into Dialog, a web-based contact and issue tracking database provided by the Department. The system shall provide an automated report to CDOT each week. All inquiries and complaints shall be followed up with a return phone call or email from either the Contractor and, when necessary, CDOT.

Photos/Video

The Contractor shall take and submit photos/videos of the project work on regular intervals. A cell phone camera is permitted. Photographs/videos may include traffic control, paving,

slope repair, erosion control, bridge work, and other key areas of work identified by the Contractor or CDOT for use in reports to interested agencies, social media, and flyers. A minimum of two digital copies of photographs/videos shall be submitted each month to CDOT.

Paid Advertisements

The Contractor shall work with CDOT to develop an ongoing paid advertising strategy to share construction information as well as overall project purpose prior to construction and at key project milestones. The advertising strategy and placements will be submitted to CDOT for review and approval.

Public Meetings

Over the duration of the project the Contractor shall host two Public Meetings per year. The meetings may be contractor-hosted in person or telephone town hall public meeting and will be conducted at least two weeks prior to the start of work and at key milestones throughout the project. Participants will include the Colorado Department of Transportation, local elected officials, city/county staff, surrounding local agencies and businesses, residents and the traveling public. Meetings will be held locally at a convenient location that will accommodate the above attendees. The Contractor shall publicize the meeting through multiple means including local media, email, inserts in local newsletters, flyers, mailers and others. The focus will be to inform attendees of project plans and schedules and to provide information on how those interested can receive updates on the project (via email address list or CDOT's GovDelivery messaging system). The Contractor will have available for viewing project displays that will provide information on work, phasing, traffic impacts, and other project information of interest to the public.

Stakeholder Meetings

The Contractor shall organize at least two meetings focused on local and regional businesses prior to the commencement of construction and also at designated milestones during the Project.

The Contractor shall, in coordination with CDOT, respond to all feasible requests to attend regular community and stakeholder meetings, such as meetings organized by nonprofit groups and neighborhood and business associations. The Contractor shall provide appropriate technical staff as required

The Contractor shall also organize informal smaller meetings with the Project Director, one-on-one stakeholder outreach, town hall teleconferences with key stakeholders prior to major construction phases or as necessary.

Personal Contacts

A member of the Contractor public information team will manage and implement email and phone contacts through the duration of the Project. More focused, individual contacts will be necessary to keep the public aware of all issues pertaining to the Project, such as all road and driveway closures and utility disruptions that impact a specific stakeholder or group of stakeholders. Contact will occur according to Response Protocol and will consist of providing information on the planned work, impacts, expected duration of the work, contact information, and any other Project-related items.

The Contractor shall also deliver flyers and other information to impacted stakeholders such as businesses and residents near the construction activities, such as start of construction phases, access impacts, schedules, etc., as deemed necessary.

Stakeholder Contact

The Contractor shall work to develop a master distribution list of contacts to be used for general public information, publications, and informational flyers/newsletters. CDOT's C-470 database established through the EA process shall be used as the basis for development of this list/database as well as CDOT's "govdelivery.com" system. This list or database shall be presented to CDOT for review, prior to NTP2.Through the Contractor's data gathering process, the Contractor shall assist CDOT in supplementing the C-470 database and govdelivery.com.

Tours and Special Events

The Contractor shall provide media, businesses and government officials tours of the construction areas and to support the coordination of special events (groundbreaking or grand opening or other key milestones). The Contractor will provide representatives of the contractor to participate in tours and events, as well as assist in the coordination of events.

Lane Closure Reports

The Contractor shall submit a Lane Closure Report each Thursday by noon, for the following week's activities (Saturday through Friday), to the contacts listed on the Lane Closure Report and as requested by CDOT. CDOT will provide an electronic copy of this report.

Traffic Alerts

The Contractor shall create a traveler alert to distribute on GovDelivery weekly. The alert shall include mainline and side road closures, ramp closures and any activity that may impact the traveling public. The alert should be sent for approval one day prior to distribution. For more immediate road work, the Contractor shall contact the Traffic Management Center to provide information for VMS boards and GovDelivery alerts.

Web Page Updates

The Contractor shall work with CDOT to develop internet web page content specifically for this project and provide consistent updates with the latest project information (web page development experience is not necessary as the Contractor will only supply information for the CDOT web page template). It shall contain all appropriate links to/from other sites if applicable, e.g., local city, county, bus service, etc. Contractor will ensure the web page is updated at least weekly with pertinent schedule information, new photos, contact information, and other information as determined by CDOT.

Project Fliers

At least 10 working days prior to the start of work and for key construction milestones, the Contractor shall prepare and deliver fliers to each property owner potentially impacted by the highway work zone such as properties with direct access to the highway, nearby businesses, schools, homes, churches or others who rely on regular traffic access in the construction zone. The flier shall be developed using the CDOT template. An email containing the flier shall also be sent to all those known to use the project limits having

significant or daily use of the roadway contained within the project corridor. Examples of these are bus services, community centers, schools. Additional fliers may be required, as directed by CDOT in consultation with the C-470 Communications Manager, and may be delivered via http://uspseverydoordirectmail.com, the use of a mailing list from county GIS mapping, or other approved method.

The flier shall provide the anticipated project start and end date, location and description of work, traffic impacts and hours/days of operation, Contractor's project information line, email address, web address, project map (if necessary) and a construction safety message as defined by the department. Flier may also contain contractor logo, if desired. Fliers shall be submitted to CDOT for Approval. The Contractor shall contact CDOT for a flier template which will include CDOT's logo, project logo, or both. All information that is made public must first be Approved by CDOT's Communications and Project Managers. Allow five working days for CDOT approval, 48 hours in cases of rapid response.

Language Assistance for LEP Persons

CDOT is required to provide access to Limited English Proficient (LEP) persons. LEP persons are individuals for whom English is not their primary language and who have a limited ability to read, write, speak or understand English. Examples of language assistance include, but are not limited to, translation of meeting notices and interpretation services at meetings. At a minimum, the Contractor shall work with CDOT to provide interpretation services upon request by an LEP person. Additionally, if the community to which the project flyers shall be distributed has greater than 5 percent LEP persons, the flyers shall be translated. The Contractor shall document all measures taken to communicate with LEP persons and record all requests for language assistance.

Public Information Collateral

The Contractor shall develop a variety of outreach collateral to share coping information to the public as necessary for major project milestones such as long-term closures or impactful construction activities (i.e. nighttime noise, restricted access, utility impacts, etc). Collateral could include newsletters, fact sheets, flyers, social media updates, etc. The Contractor shall use CDOT provided branding on all public information materials throughout the Project and adhere to CDOT's Branding Standards Guidelines. The Contractor shall not use its own logos or Subcontractors logos for public communications materials.

Construction Signing

A minimum of one week prior to start of work, the Contractor shall erect signs at both ends of the project limits, with the estimated dates when the project will commence and end. The signs shall include the Contractor's name and public information contact number.

4.2.3 Availability and Response Protocol

Response Protocol to CDOT and the public

The Contractor shall conform to Table1 in responding to correspondence from stakeholders and the public:

Table 1
RESPONSE PROTOCOL

TYPE OF COMMUNICTION	TIMING OF RESPONSE
Hotline Calls	Check messages throughout day Respond same day (initial call) or within 24 hours (including weekends if work is occurring)
Email	Same day (within two business days for high volume situations)
Call from CDOT Staff	As soon as possible
Webpage Inquiries	Same day (within two business days for high volume situations)
Public Meeting Inquires	Within one week of the meeting

Deliverable protocols to the public

The Contractor shall conform to Table 2 in providing the following information to the public:

Table 2
DELIVERABLES AND SUBMITTAL TIME TO THE PUBLIC

NOTIFICATION PROTOCOL	
Proactive Notification Element	**Timing**
Full road closures, detours, and major traffic impacts lasting seven days or longer	14 days prior to the beginning of activity in any area of the Project.
Major project activities (such as major lane shifts, bridge demolitions, etc.) lasting seven days or less	7 days prior to the beginning of the activity
Other remaining types of construction Activities in any area of the Project including: ▪ Night Work ▪ Utilities ▪ Change of business/residential access	7 days prior to the beginning of activity in any area of the Project or as determined jointly by teams
Other construction updates (e.g, cancellation of planned closures, additional lane closures, closure removals, major	As soon as known with at least 24 hours' notice

traffic shifts, etc.) that directly impact the public.	

When scheduling outreach activities, allow five working days for CDOT approvals prior to the distribution of information to the public.

4.3 Crisis Communications Plan

The Contractor shall prepare and maintain a Crisis Communications Plan for the Contractor's response to emergencies and incidents during construction, long-term operations and maintenance. The Contractor shall coordinate this approach with the Contractor's overall Incident Management Plan described in Book 2, Section 16.

In an event of a crisis, CDOT will be the lead agency to handle communication with the media, public, CDOT staff, etc. The Contractor shall be available to help coordinate with CDOT and provide information necessary to respond to the crisis.

The Contractor's crisis communication approach for its public information staff shall include:

1) Designated staff to respond to the emergency
2) Types of potential emergencies
3) Approaches to addressing potential emergencies
4) Boilerplate messaging that includes:
   i. Cause of specific disruptions (whether construction related or not)
   ii. Actions being taken to alleviate the problem
   iii. Impact to the public and notification procedures
   iv. Anticipated duration of the disruption

The Contractor shall provide specific details on internal coordination and communication that will occur with other Contractor groups, CDOT, and other Stakeholders.

Emergency Information Dissemination –Communications Tree

The Contractor shall establish and manage an emergency response telephone and/or email tree. All appropriate personnel shall be included on this communications tree for immediate response in the event of an emergency. The telephone/email tree shall be divided into areas of expertise so the proper people are called and/or emailed for specific emergency situations. The C-470 Project Director and Communications Manager, and the Contractor's Engineer shall be included on the communications tree for notification of any emergency that may arise. The Contractor shall develop and maintain a contact list of emergency service providers as part of its crisis communications approach. The Contractor shall provide information to emergency service providers. The Contractor shall submit the emergency response communications tree to CDOT for Acceptance at NTP1.

4.4 Deliverables

The Contractor shall submit the following for Review, Approval, and/or Acceptance:

Deliverable	Review, Acceptance, or Approval	Schedule
PCM Name and Credentials and Contact Information	Approval	Prior to NTP 1
Construction Communications Plan	Approval	Prior to NTP 2
Construction Communications Plan Updates	Approval	Quarterly
Crisis Communications Plans	Approval	Prior to NTP 2
Crisis Communications Plans Updates	Approval	Quarterly
Emergency Response Telephone Tree	Acceptance	Prior to NTP 1
Local Telephone Hotline	Acceptance	Prior to start of construction work
Stakeholder Distribution List (if required for non-work zone flyer recipients and emergency service providers)	Approval	At Pre-Construction Meeting and Prior to NTP 2
Lane Closure Reports	Approval	Weekly, on Thursday by noon
Traffic Advisories/Media Releases	Approval	48 hours prior to scheduled distribution date
Fliers, posters or other public material	Approval	At least 10 working days prior to the initial start of construction for the first project flier. 5 Working Days prior to the scheduled distribution date In cases of rapid response, 48 hours prior to distribution
Photos/Video	Review	Two a month or as requested.

All Deliverables shall also conform to the requirements of Book 2, Section 3 – Quality Management.

5.0 ENVIRONMENTAL REQUIREMENTS

The Contractor shall comply with all requirements of all applicable Environmental Laws and Governmental Approvals issued there under, whether obtained by CDOT or the Contractor. The Contractor shall prepare an Environmental Compliance Work Plan for the Project, specifically identifying all of the environmental compliance requirements for the Project and the Contractor's approach for complying with the requirements.

The Draft Environmental Compliance Work Plan shall be submitted to CDOT for Review within 30 Days after NTP1. A Final Environmental Compliance Work Plan shall be submitted to CDOT for Approval prior to NTP 2. Delivery shall include one electronic copy on CD-ROM and 2 paper copies of the Work Plan. Approval of this Work Plan will be required as a condition for issuance of NTP 2.

The Environmental Compliance Work Plan shall include:

1. All environmental mitigations and elements included in Book 3, Section 5; C-470 Corridor Revised Environmental Assessment.
2. All environmental mitigations required in the Technical Requirements.
3. Description of means and methods to meet all the mitigation requirements and maintain compliance with all Environmental Laws and Governmental Approvals.
4. Description of the process for tracking environmental commitments throughout the duration of the Work by the Contractor.

The Contractor shall report on the status of activities under taken in accordance with the Environmental Requirements on a regular basis. During the period beginning with NTP2 through the Substantial Completion Date, the EM shall submit an Environmental Compliance Work Plan Addendum (Addendum) monthly for Acceptance. The Contractor shall submit an Addendum within 15 Calendar Days following the end of the reporting period. The Addendum shall:

1. Include the current status of compliance with the Environmental Requirements;
2. Document any pertinent environmental issues and include a narrative of the compliance actions and environmental activities which have occurred during the reporting period;
3. Include a summary of any stakeholder communications and Governmental Authority communications that have occurred during the reporting period;
4. Include a summary that lists the plan sets and submittals which have undergone environmental cross-disciplinary review since the last Addendum;
5. Include dated photographs documenting environmental compliance and activities; and
6. Include any other content requirements specified in this Section 5.

All narratives shall include enough detail to fully document the environmental activities. If the Department requests additional information be included in the monthly Addendum, the Contractor shall revise the Addendum and resubmit the report for Acceptance.

The Environmental Compliance Work Plan shall be updated as a whole every six months, to include all monthly addendums, and shall be submitted to CDOT for Acceptance.

The Contractor shall employ and utilize an Environmental Manager (EM) on the Project with a minimum of five years of experience in Environmental Sciences. The EM shall be responsible for implementing all the environmental design, construction and operational commitments and all conditions of the Environmental Approvals for the Project. The EM shall be the primary liaison between the Contractor and CDOT on environmental issues. The EM shall be the lead responder to any non-compliance findings issued by CDOT or the Construction Quality Manager. The Environmental Manager shall lead a field review with CDOT environmental staff to discuss environmental issues at least once a month during active construction periods, and shall have the authority to stop construction if Work activities violate Environmental Laws, regulations or permits, or jeopardize human health and safety. In addition, the EM shall:

1. Coordinate the implementation of all environmental procedures.
2. Ensure full compliance with all Environmental Laws and Environmental Approvals in design, construction, and operations.
3. Assure that environmental tasks are performed by qualified environmental professionals and provide the resources needed to perform Work to meet the Environmental Requirements. Activities performed by environmental professionals shall be reported in the Addendum and include the resumes of the individuals performing the Work.
4. Lead environmental cross-disciplinary reviews of all design submittals to confirm compliance with all environmental design commitments and include a summary of the findings in the update to the Environmental Compliance Work Plan.
5. Perform formal reviews of Changes, design changes, and field design changes to confirm compliance with all Environmental Requirements and include a summary of the findings in the update to the Environmental Compliance Work Plan.
6. Measure the number and severity of non-conformances with the Environmental Requirements and include a summary of the findings in the update to the Environmental Compliance Work Plan.
7. Implement improvement strategies to reduce the number and severity of non-conformances with the Environmental Requirements and include a summary of the findings in the update to the Environmental Compliance Work Plan.
8. Monitor Construction Work for conformance with Environmental Requirements and include a summary of the findings in the update to the Environmental Compliance Work Plan.
9. Plan and conduct the Environmental Compliance and Mitigation Training Program for the Contractor's supervisory staff. All activity related to the Environmental Compliance and Mitigation Training Program, including sign in sheets of the participants, shall be reported in the update to the Environmental Compliance Work Plan.
10. Lead a field review with the Department to review the Project and environmental issues every month during the Construction Period. This field review can be counted as a substitute for the EM's weekly field review.
11. Lead the Environmental Task Force meetings. Submit the minutes of these meetings in the update to the Environmental Compliance Work Plan for the appropriate period.
12. Attend all public meetings and participate as needed.
13. Write and submit the update to the Environmental Compliance Work Plan for Acceptance.

14. Provide documentation certifying the completion of all Environmental Requirements.

A Completed Environmental Compliance Work Plan shall be submitted to CDOT for Approval as a condition for Final Acceptance of the Project.

5.1 Environmental Resources Requirements

5.1.1 Air Quality

The Contractor shall obtain an Air Pollution Emission Notice (APEN), including a Fugitive Dust Control Plan and construction and demolition permit from the Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control Division (APCD). The Contractor shall document in the Construction Air Quality Plan and implement procedures for controlling air quality and dust which shall include Best Management Practices (BMPs) consistent with the Fugitive Dust Control Plan including but not limited to:

- Using wind barriers and/or wind screens to minimize the spread of dust where large amounts of Material are stored
- Using a wheel wash station and/or large diameter cobble apron at egress/ingress areas to minimize dirt being tracked onto public Streets
- Using a water systems for street cleaning Equipment capable of diminishing dust during sweeping operations on public Streets
- Wetting exposed soils and soil piles for dust suppression
- Covering trucks hauling soil and other fine Materials
- Stabilizing and covering stockpile areas
- Re-vegetating exposed areas
- Minimizing off-Site tracking of mud and debris by washing construction Equipment and temporary Stabilization
- Limiting vehicle speed of construction-related Equipment when off road
- Prohibiting unnecessary idling of construction Equipment
- Using low sulfur fuel
- Locating diesel engines and motors as far away as possible from residential areas
- Locating staging areas as far away as possible from residential areas
- Requiring heavy construction Equipment to use the cleanest available engines or to be retrofitted with diesel particulate control technology
- Using alternatives for diesel engines and/or diesel fuels (such as: biodiesel, liquefied natural gas, compressed natural gas, fuel cells, or electric engines)
- Installing engine pre-heater devices to eliminate unnecessary idling during winter time construction

- Prohibiting tampering with Equipment to increase horsepower or to defeat emission control devices effectiveness
- Requiring construction vehicle engines to be properly tuned and maintained
- Using construction vehicles and Equipment with the minimum practical engine size for the intended job

All non-road Equipment shall use ultra-low sulfur diesel fuel. The Contractor shall minimize excessive idling of inactive Equipment or vehicles. If construction Equipment is creating excessive air quality emissions that have a potential to affect air quality for operators or persons working/living in the area, Equipment shall be taken out of operation until fixed or replaced. The Contractor shall also locate stationary emissions Equipment with consideration of public health and environment.

A Construction Air Quality Plan and Fugitive Dust Control Plan shall be submitted to CDOT for Acceptance prior to issuance of NTP 2.

5.1.2 Noise

5.1.2.1 General

The Contractor shall perform a noise analysis based on its final design. Results of the noise analysis shall be documented in a preliminary and final Noise Technical Report and submitted to the CDOT for Acceptance. For information the FHWA Traffic Noise model (TNM) used in the EA analysis is available to the Contractor as provided in the Reference documents.

The noise analysis and Noise Technical Report shall follow the format of the EA analysis and include the same receiver locations. If receiver locations are changed, new locations must be Reviewed by CDOT and documented in the Final Noise Report. The noise analysis shall utilize the same model used in the EA and shall be produced in accordance to the standards and procedures of the CDOT *Noise Analysis and Abatement Guidelines*.

The Noise Technical Report shall determine and document the noise effects of any changes to the vertical and horizontal alignment from the Reference Design. The noise analysis and Noise Technical Report shall include a detailed description of the locations where the horizontal and vertical roadway elevations have changed from the Reference Design. The noise analysis and Noise Technical Report shall determine if any new neighborhoods have become eligible for noise abatement. If any new areas become eligible for noise abatement due to changes to the vertical or horizontal alignment, the Contractor shall include the analysis for recommended noise abatement in the noise analysis and report. The Contractor shall assure proposed mitigation is consistent with mitigation standards identified in the C-470 Revised EA State and Federal guidelines.

The Contractor shall submit documentation with the noise analysis and Noise Technical Report verifying that the analysis was performed by a qualified individual with expertise in the field of highway noise analysis in Colorado. If additional noise abatement is required due to the Contractor initiated changes to the vertical or horizontal alignment, all costs for the additional noise abatement shall be borne by the Contractor.

5.1.2.2 New Noise Abatement

New noise abatement is required in the areas identified in the C-470 Revised EA. The Contractor shall optimize the design of the noise abatement infrastructure to maximize the number of receivers receiving a reduction of 5 dBA or greater per CDOT/FHWA guidelines.

The Contractor shall submit a preliminary Noise Technical Report which contains the optimized design of the proposed noise abatement in the affected neighborhood. Acceptance of the preliminary Noise Technical Report is required before the Benefited Receptor Preference Survey can be conducted.

When the preliminary Noise Technical Report has been Accepted by the CDOT, the Contractor shall conduct the Benefited Receptor Preference Survey as described in the CDOT *Noise Analysis and Abatement Guidelines*. The Contractor shall provide all material necessary to conduct the survey including exhibits, flyers, door hangers, ballots and return mail envelopes. The Contractor shall conduct a public meeting on the proposed noise abatement design. The Contractor shall allow the CDOT the opportunity for ongoing over the shoulder review of all planning activities associated with the Benefited Receptor Preference Survey. The Contractor shall submit for Approval the plan of the Benefited Receptor Survey, including the geographic limits of the survey, procedures for conducting the survey, and printed material and other media to be used for the survey at least 14 Calendar Days before completing the survey.

Additional new noise abatement will be required if changes to the final vertical or horizontal alignment, or any new Type I action, trigger eligibility as referenced in the Noise Analysis and Report subsection above. New noise abatement infrastructure requirements triggered by changes to the geometry shall be the responsibility for the Contractor.

After the Benefited Receptor Preference Survey is completed, a Final Noise Technical Report shall be completed to document the final design noise analysis, final geometry and details of the noise barriers. This report shall be submitted to the CDOT for Acceptance as part of the Final RFC Documents submittals.

If the Benefitted Receptor Preference Survey results in elimination of noise abatement identified in the C-470 Revised EA, a deductive change order shall be executed per Book 1, Section 13.

5.1.2.3 Existing Noise Abatement

All existing noise abatement structures that are removed, damaged, or otherwise impacted as a result of the Construction Work shall require full replacement. Replacement noise abatement structures shall be constructed to the structural and aesthetic requirements as set out in Section 17 of the Technical Requirements and the Corridor Aesthetic Guidelines. Where existing noise walls are to be replaced or relocated, the replacement noise mitigation shall be in place prior to removal of the existing noise mitigation. Where this is not feasible, the Contractor shall include temporary noise mitigation. If existing noise walls are relocated inside of existing CDOT ROW the Contractor will be required to install new ROW fence in accordance with the corridor requirements.

Top of existing noise barrier elevations shall be documented before the removal of any existing structure. If final design noise analysis determines that top of barrier or structure elevations are lower than their existing elevations, the Contractor shall demonstrate that no new visual sight lines are created.

5.1.2.4 Additional Noise Abatement Requirements

a. Proposed noise walls shall be placed in locations that will accommodate the Ultimate configuration.

b. Noise walls and other abatement measures shall follow the requirements set out in Section 17 and the Corridor Aesthetic Guidelines.

c. Noise walls shall be designed and constructed without open joints or gaps. Joints between noise wall Elements shall be minimized. Where joints are necessary, they will be designed is such a way that no light can pass through them. If a sealant is utilized to close any joint, it shall have a design life equal or greater than the wall. Proposed noise wall designs and location information shall be included in the Contractor's public information program.

5.1.2.5 Construction Noise and Vibration

The Contractor shall be required to prepare and submit to CDOT, for Acceptance with the Final RFC Documents submittals, a mitigation plan for noise and vibration that outlines allowable daytime and nighttime activities, projected noise levels, and locations and types of noise and vibration abatement measures for the associated construction activities.

The Contractor shall comply with all applicable local noise ordinances and regulations, unless the Contractor secures a variance from the municipalities. If permits are required, they shall be acquired by the Contractor prior to the start of any associated construction Activities and the Contractor shall be solely responsible for compliance with the permit requirements.

5.1.3 Cultural/Historical Resources, Archaeological Resources, and Historic Section 4(f) Resources

The High Line Canal (water culvert, not the trail culvert) that crosses under C-470 has been identified as an historic resource (Smithsonian ID numbers 5AH388 and 5DA600.3). The current Conceptual Design for the C-470 Proposed Action avoids impacts to this resource. Instead of extending this culvert, a concrete retaining wall would be extended from the edge of the pavement down the slope to within 15 feet of the box culvert on both the north and south sides. The concrete wall would stabilize the earthen slope protecting the High Line Canal from erosion associated with the highway. The Contractor shall incorporate these measures to avoid impacts to this protected historic resource.

5.1.3.1 Construction

The Contractor shall be responsible for notifying CDOT of any unidentified historic, eligible for listing on the National Register of Historic Places, or archaeological resources encountered or unearthed during construction. Upon discovery of any historic or archaeological resources, the Contractor shall immediately cease work in the vicinity of the discovery, fence off the area, and notify the CDOT archaeologist or cultural resource staff by calling the Cultural Resource Program Manager at 303-757-9631. The Contractor shall not resume Work in the area until receiving formal notification from CDOT allowing Work to re-commence. If historic or archaeological resources are discovered, CDOT will determine the resource mitigation requirements that the Contractor shall implement. The Contractor shall provide archival photographic documentation if any historic buildings are to be demolished as part of this Project. The Contractor shall clearly label environmentally sensitive areas e.g., wetlands and riparian

areas, Section 4(f) resources, etc., with "No Parking and No Staging Area" on final plan sheets.

5.1.4 Paleontology

Denver Formation fossils may be encountered during construction Activities. The Contractor shall provide design plans to the CDOT paleontologist for Review at least 14 days prior to associated construction Activities to determine the extent of impact to the Denver Formation and to determine if monitoring during construction is required.

If paleontological resources are uncovered during Project construction, Nicole Peavey (nicole.peavey@state.co.us and 303/757-9632) should be notified immediately and CDOT Specification 107.23 followed.

5.1.5 C-470 Trail, Parks and Recreation

5.1.5.1 C-470 Trail (Transportation Resource)

The Work is expected to result in relocation of approximately 5.8 miles of the C-470 Trail that generally parallels the C-470 highway for its entire length. Subject to other construction restraints, it is CDOT's intent to minimize any disruption of the C-470 Trail as a transportation resource for non-motorized traffic. The Contractor will identify potential new sections of trail to be constructed prior to closing any portion of the existing C 470 trail, to avoid disruption. The Contractor shall be responsible for obtaining CDOT approval for any Work that would disrupt C-470 Trail use, including specification of the location schedule and duration of any detours. The Contractor shall develop and implement a Communication Plan for providing advance notice of trail disruption to local government agencies and trail user groups.

Note: A short portion of the C-470 Trail coincides with the High Line Canal Trail recreational resource. This section that includes a culvert crossing under C-470 is discussed below under the topic of Parks and Recreation.

5.1.5.2 Parks, Recreation and Recreational 4(f) Resources

The Work is anticipated to result in temporary closures of three trails that cross under C-470. These are Mary Carter Greenway Trail (along the west bank of the South Platte River), High Line Canal Trail (culvert shared with C-470 Trail), and Willow Creek Trail. The Mary Carter Greenway Trail and Willow Creek Trail are managed by the South Suburban Parks and Recreation District (SSPRD), and the High Line Canal Trail is managed by the Highlands Ranch Metropolitan District (HRMD). Subject to other construction restraints, it is CDOT's intent to minimize any disruption of these existing trail crossings of C-470. The closure and detour of Willow Creek and Highline trails were approved with a Section 4(f) Temporary Occupancy exclusion and thus the closure and detour of each of these trails shall be limited to a cumulative of 6 months. The closure and detour of the Mary Carter Greenway Trail was approved with a Transportation Enhancement exclusion and thus the closure and detour shall be limited to a cumulative of 6 months.

The Contractor shall coordinate with SSPRD and HRMD, and then obtain CDOT Approval for any Work that would disrupt the use of these three trails, including specification of the location, schedule, and duration of any detours. The Contractor shall coordinate with SSPRD and HRMD to gain approval of trail detour signing messages and placement. The Contractor shall develop

and implement a Communication Plan for providing advance notice of trail disruption to local government agencies and trail user groups.

SSPRD coordinates a number of races and other bicycle events each year on the Mary Carter Greenway Trail. The Contractor shall obtain SSPRD's schedule of events and must develop and coordinate construction schedules to avoid affecting the Mary Carter Greenway Trail events. A minimum two-week advance notice must be provided to SSPRD and HRMD prior to any temporary trail closure. The Contractor shall provide signed detour routes for each closure and provide signage to inform trail users of the location and duration of the detours.

5.1.6 Vegetation

The Contractor shall minimize tree removal and disturbance to vegetation. In riparian areas that are subject to Colorado Senate Bill 40 (SB 40) requirements, all trees equal to or greater than 4 inches diameter at breast height (DBH) that are removed shall be replaced with native trees at a 1:1 ratio and shrubs that are removed shall be replaced with native shrubs at a 1:1 ratio based on total aerial coverage determined through the SB 40 Wildlife Certification required in Section 5.4.4. The Contractor shall supply this data to CDOT.

The Contractor shall submit in writing the quantity and location of all trees removed that they propose to replace for approval by CDOT and CPW. The Contractor shall prepare a letter including mapping and 90% Construction Plans for Riparian Impact Areas for the Senate Bill 40 Wildlife Certification for CDOT Acceptance. CDOT will submit the documentation to the Colorado Division of Parks and Wildlife. The Contractor shall follow the SB 40 mitigation plan approved by Colorado Parks and Wildlife after submittal of an application for an SB 40 Wildlife Certification. In all other areas (non SB 40 areas), the Contractor shall comply with CDOT's tree replacement practice of replacing all trees, natives and non-natives, equal to or greater than 4 inches DBH with native trees at a 1:1 ratio. Removal of additional trees and the substitution of one tree or shrub species with another must be accepted by the Regional CDOT Biologist or by a CDOT Landscape Architect.

The Contractor shall manage impacted landscape areas (irrigated or otherwise) to optimize the longevity and maintainability of the existing vegetation. The contractor shall supply a native seed mix recommendation for CDOT Review and Acceptance. The Contractor shall reseed and protect temporary disturbance areas with CDOT-approved BMPs to avoid disturbance to existing vegetation. All seed, mulch and mulch tackifier shall be applied in accordance with requirements of the Contract.

Prior to construction, the Contractor shall update the weed mapping of the project area and prepare a current Integrated Noxious Weed Management Plan for inclusion in the Final Environmental Work Plan. The plan will include a variety of species-specific control methods based on the size of the weed populations and the surrounding landscape. The plan will be implemented throughout project construction as appropriate. Following construction, mitigated sites will be monitored at least twice over the first growing season and follow-up weed control will be provided where needed.

5.1.7 Wildlife

South Platte River Wildlife Crossing: An existing chain link fence extends from the South Platte River along the north and south side of C-470. In consultation with the CDOT Region 1 Biologist, the Contractor shall replace this fencing with new fencing designed to direct large mammals to safely cross under C-470 at the South Platte River. After construction of the South Platte River bridges, the Contractor shall re-vegetate disturbed areas near the bridge with native riparian shrubs such as skunk brush and willow in attempt to attract deer to cross under C-470.

Fish, Reptiles and Amphibians: Habitat for sensitive species was not identified in the project area, but common fish and wildlife species are present. Impacts to the South Platte River and other creeks and surrounding wetland/riparian habitat shall be minimized as much as possible. Required mitigation per SB 40 Certification shall be implemented as part of this project.

5.1.7.1 Black-Tailed Prairie Dogs

Biological surveys have documented approximately 20 active prairie dogs colonies comprising nearly 90 acres along C-470 in the project area. The Contractor will follow all applicable local, State and Federal laws, policies and regulations including the *CDOT Impacted Black-Tailed Prairie Dog Policy* (CDOT, 2009)(attached), *Revision of Section 240 – Prairie Dog Management* (attached) and the CPW regulations (*CPW General Provisions*). Passive relocation of prairie dogs will be the first method of mitigation for impacts. The second option, relocation, is not feasible as an appropriate relocation site is unlikely to be found. The final option for prairie dog mitigation will to humanely euthanize according to CDOT policy.

Prior to Release for Construction, the Contractor shall submit BTPD Management Plan specifying expected impacts and the manner by which the BTPD policies will be complied. The BTPD plan will be Reviewed and Approved by CDOT, and possibly the CPW depending on the level of impact, and any other agencies as necessary. Approval is required before impacts to BTPD habitat or species can occur.

If prairie dogs are relocated or removed during the burrowing owl nesting season (March 15 through October 31) the affected habitat shall be surveyed by a qualified biologist for the presence of burrowing owls in accordance with CPW survey protocols. Surveys shall be timed such that the final burrowing owl survey is completed within one week of disturbance to BTPD colonies and submitted to CDOT for Acceptance. Exterminating prairie dogs and donating them to the Rocky Mountain Raptor Program is an option.

5.1.7.2 Migratory Bird Treaty Act

The Contractor shall comply with the Migratory Bird Treaty Act (MBTA) at all times, including conducting pre-construction surveys for nesting birds set forth by U.S. Fish and Wildlife Service (USFWS), Colorado Parks and Wildlife (CPW), and *Revision of Section 240, Protection of Migratory Birds* (attached) . The Contractor shall schedule Work to avoid taking (pursue, hunt, take, capture or kill; attempt to take, capture, kill or possess) migratory birds protected by the MBTA. The incidental taking of a migratory bird shall be reported to CDOT. The Contractor shall be responsible for all penalties levied by the USFWS for the taking of a migratory bird.

Active swallow nests were identified under existing bridge structures. The Contractor shall complete nest surveys to evaluate the presence of active nests within the study area. The Migratory bird nest survey shall be submitted to CDOT for Review prior to impacting existing structures that may contain active bird nests. Inactive nests, once confirmed by the wildlife biologist, may be removed at any time to discourage nesting. To prevent new nest establishment, the Contractor will implement techniques such as netting under bridges and culverts during the non-breeding season or removal of new nests under construction. The site should be visited every three to four days to prevent new nests from being completed, unless construction activity is continuous on a daily basis during active nesting season.

Raptors have been observed in the study area. The Contractor shall complete raptor nest surveys to evaluate the presence of active raptor nests within the study area. If an active nest is located in or near the study area, the USFWS and CPW shall be contacted regarding use of seasonal buffers to prevent disturbance to nesting birds during construction.

Land-clearing activities in natural habitats shall be timed to avoid the breeding season and to avoid impacts to active bird nests. If required, trees shall be cleared prior to April 1 or after August 31 to prevent raptors (and other birds) from nesting on-Site and to avoid the taking of, or disturbance to, active nests during the breeding season. The Contractor will comply with Revision of Section 240, Protection of Migratory Birds (attached).

Burrowing Owls can be present and share habitat with Prairie Dogs. The Contractor shall conduct burrowing owl surveys within black-tailed prairie dog (BTPD) colonies between March15 and October 31 where impacts to BTPD colonies are planned. The Contractor shall follow CPW policies regarding burrowing owl surveys (CPW, 2007, Recommended Survey Protocol and Actions to Protect Nesting Burrowing Owls When Conducting Prairie Dog Control).

The Contractor shall retain a qualified wildlife biologist, with a minimum of three years' experience conducting migratory bird surveys, to implement the requirements of the MBTA. The Contractor shall submit documentation of the biologist's education and experience to CDOT for Acceptance prior to commencement of any associated Work. A biologist with less experience may be used by the Contractor subject to the Acceptance of CDOT based on review of the biologist's qualifications. Documentation of the nest surveys shall be submitted to CDOT for Review.

5.1.8 Visual

The Contractor shall design corridor improvements per the Project Aesthetic Plans. If local governments desire to fund localized upgrades above the Project Aesthetic Plans, CDOT and the Contractor will work with them to pursue these possibilities through Betterments.

Staging areas that are to remain in place longer than 90 days shall be fenced and screened. Temporary construction lighting shall be shielded and directed at Work areas to minimize glare and ambient light conditions in nearby areas.

5.1.9 Water Quality

Permanent water quality features are incorporated into the project's conceptual design to comply with CDOT's MS4 Permit for water quality treatment. Refer to Section 12 for permanent and temporary water quality features and requirements.

5.1.10 Recognized Hazardous Materials

Recognized Hazardous Materials (RHM's) are defined as the presence or suspected presence of Hazardous Substances which may require management and/or disposal. Hazardous Substances may exist on the surface, subsurface, groundwater, or on structures to be demolished, and maybe mixed with soil, water, and/or other waste materials.

RHM's have been identified at a number of locations adjacent to the Project. The Contractor's attention is directed to the Phase I and other applicable Contract Documents, for information related to the RHM's. The Contractor is advised to thoroughly read and understand the findings and requirements in the environmental site assessments that have been prepared for any RHMs within the project limits. The Contractor shall develop a Materials Management Plan (MMP) to be submitted for Approval by CDOT prior to issuance of NTP2 . The MMP shall include a Sampling and Analysis Plan (SAP) for areas that may not have been adequately characterized for disturbance. The Contractor shall comply with all provisions set forth within the Approved MMP.

Materials Management Plan (MMP): The MMP shall identify potential RHM's, locations, extent of impact, proposed Remediation Work, and avoidance measures, investigation measures, and a contingency plan for addressing unforeseen conditions. The plan shall identify the Contractor's representative responsible for environmental compliance, the proposed design and construction staff, and approach to implementation of the MMP. In addition to meeting the requirements of Section 250 of the Standard Specifications the MMP shall include the following provisions:

The Contractor shall manage all RHM's including soils, groundwater, surface water, and other contaminated substances to prevent exposure to project personnel and the public, and to prevent any contamination of non-contaminated areas.

The Contractor shall classify such wastes according to one of the following categories:

1. Hazardous waste as defined under the Resource Conservation and Recovery Act (RCRA) requiring off-Site disposal and/or treatment
2. Contaminated soils requiring off-Site disposal
3. Soils to be stockpiled for further characterization
4. Soils with concentrations of waste constituents below regulatory concern that can be reused without restriction
5. Wastewater requiring off-Site disposal and/or treatment
6. Impacted water to be held for further characterization
7. Asbestos containing material (ACM) discovered during construction or demolition
8. Lead-based paint associated with Structures, signage, light posts, etc.
9. Waste material to be contained for further characterization
10. Contaminated groundwater requiring on-Site treatment or off- Site disposal

Prior to commencing any Remediation Work Activities, a scope of work shall be submitted to CDOT for Approval. The Contractor shall utilize the most cost effective approach in the performance of any remedial action deemed necessary. Remediation Work will not include sampling, characterization, stockpiling or disposal of materials that are determined not to require off-site disposal and/or treatment.

The Contractor shall not allow Hazardous Substances to be spilled or tracked off site at any time during the Project.

The Contractor shall be responsible for locating storage facilities and disposal sites for RHM's that are to be removed from the Work Site.

The Contractor shall maintain documentation of completed waste profiles, manifest forms, and bill-of-lading forms for proper transportation and disposal of materials off-site. This information shall be available at all times for review by CDOT. The Contractor shall be held responsible for ensuring that all requirements of the transporter and receiving disposal facility and federal, state, and local statutes, rules, regulations and ordinances are complied with and properly documented.

At the conclusion of the implementation of the MMP and VCUP activities, if determined applicable, a No Further Action Determination (NAD) petition for each of the properties where residual or unknown contamination is encountered within the Project, shall be prepared by the Contractor, submitted to the CDOT for Review and Acceptance, and then submitted to CDPHE for Review and Approval. If no residual or unknown contamination is encountered a NAD will not be required.
The NAD Petition shall include the following sections and appendices:

1. Project Background
2. Waste Management During Demolition
3. Characterization Sampling Data
    A. Soil Management and Disposal Data
    B. Waste Streams Disposed Offsite
4. Wastes Managed On Site
5. Right Of Way Maps
6. Groundwater Management and Disposal Data
7. Property Use Restrictions, Restrictions on Groundwater Use
8. Summary of Variances of Regulatory Standards
9. Qualified Environmental Professional Certification
10. Appendices
    A. Photographs, Figures, and Tables
    B. Analytical Results
    C. VCUP addendums and copies of correspondence with CDPHE and Colorado OPS, if determined applicable,
    D. Waste manifests

In addition to the MMP and SAP, the Contractor shall develop a Health and Safety Plan (HASP), and a Spill Prevention Control and Countermeasures (SPCC) Plan for each segment of work, as required by Section 250.03 of the 2011 CDOT Standard Specifications for Road and Bridge Construction, CDOT MMP, and the CDOT Asbestos-Contaminated Soil Management SOP as

appropriate. The draft plans of the HASP and SPCC shall be submitted to CDOT for Review within 30 Days after NTP1. The final plans of the HASP and SPCC shall be submitted to CDOT for Acceptance prior to NTP 2. Acceptance of these plans will be required as a condition for issuance of NTP 2.

Health and Safety Plan (HASP): The Contractor shall distribute the HASP to all employees that could be potentially exposed to RHMs. The HASP shall be displayed or made available on-site at all times. The Contractor shall develop and maintain on-site all industrial hygiene information, including "right-to-know" information. In addition to meeting the requirements of Section 250 of the Standard Specifications, the HASP shall include the following provision:

> "The Contractor shall maintain documentation and provide information to CDOT, as requested, regarding potential or actual exposure to the public. The Contractor shall maintain records of all related incidents and notify CDOT and appropriate State authorities immediately."

The Contractor shall provide to CDOT identification of all Subcontractors to be used in the performance of Activities required within this section prior to performing any such Activity. The Contractor shall maintain documentation of all pertinent certifications of all Subcontractors and make available upon request to CDOT.

Spill Prevention Control and Countermeasures (SPCC) Plan: The Contractor shall prepare a SPCC Plan. The Plan will be in accordance with *Standard Specifications Section 208*. The SPCC shall establish operating procedures for handling pollutants and preventing spills. Pollutant sources include, but are not limited to, exposed and stored soils, paints, solvents, fertilizers or chemicals, vehicle tracking, management of contaminated soils, loading and unloading operations, outdoor storage activities, vehicle/equipment maintenance and fueling, significant dust or particulate generating processes, on-site waste management practices, concrete truck/equipment washing, dedicated asphalt and concrete batch plants, and non-industrial waste sources that may be significant such as trash and portable toilets.

The Contractor shall perform Inspections per the Colorado Discharge Permit System – Stormwater Construction Permit (CDPS-SCP) to assure the construction best management practices (BMPs) are adequate for the Site conditions of the Project and are in good working condition. The Contractor shall prevent the discharge of any sediment or pollutants into any Storm Drains or receiving waters during the life of the CDPSSCP.

The Contractor shall schedule a review meeting with CDOT after receipt of CDOT comments on the MMP, SAP, HASP, and SPCC. The Contractor's Environmental Manager and the Contractor's Safety Manager shall be present at the meeting. The Contractor shall incorporate modifications into the submitted MMP, SAP, HASP, and SPCC agreed to during this meeting.

The Contractor shall comply with all provisions set forth within the reviewed MMP, SAP, HASP, and SPCC and shall maintain documentation of all pertinent certifications of all Subcontractors which shall be available upon request by CDOT. The Contractor shall comply with all applicable requirements, including, but not limited to, all federal, state, and local environmental laws and regulations and the Standard Specifications for Road and Bridge Construction, Section 250, Environmental, Health and Safety Management and any project special revisions for the management and disposal of the RHMs. The Contractor shall coordinate all Work with CDOT

and shall not discuss or negotiate with any regulatory agencies or third parties on behalf of CDOT. The Contractor shall notify CDOT within 24 hours if contacted by any regulatory agencies or third parties concerning RHMs associated or potentially associated with the Contract requirements.

Monthly Statement of Regulated Hazardous Materials Management: The Contractor shall submit RHM reports to CDOT for monthly review on all activities associated with the contract. The Contractor shall coordinate with CDOT to determine the format of the report prior to the associated construction activities.

Quarterly Summary of Hazardous Materials Management: The Contractor shall submit quarterly reports to CDOT for review and then subsequent submittal to CDPHE. The reports shall contain "Tasks/Activities Completed", "Tasks Expected for Next Reporting Quarter", "Percent Complete", and "Issues to be Resolved".

Prior to demolition activities on any Right of Way of any structures, or removal of utility lines, the Contractor shall determine the presence or absence of lead or asbestos containing materials. If lead or asbestos is present, the Contractor shall conduct abatement in accordance with Section 250, Environmental, Health, and Safety Management, of the 2011 CDOT Standard Specifications for Road and Bridge Construction, the CDOT Asbestos-Contaminated Soil Management Standard Operating procedure (CDOT 2011), the revised Section 250 Specification and relevant Occupational Safety and Health Administration (OSHA), and other State and Federal Requirements.

Payment for removal and disposal of Hazardous Materials from the Project site will be paid for by Force Account only. Time associated with hazardous materials removal and disposal shall be considered non-excusable and non-compensable.

The Contractor shall be responsible for identification and performance of all Activities required within this Section associated with Utility Work being performed for the Project.

The Contractor shall be responsible for removal of any facilities and equipment installed within the Project limits related to performance of the Work under this Section prior to completion of the Project.

5.2 NEPA Reevaluation

If the Contractor proposes or creates the need for any environmentally significant Project change as defined by each resource's policies, procedures, guidelines or regulatory requirements that results in a potential change to the environmental impact (including Alternative Technical Concepts [ATCs]), the Contractor shall be responsible for documenting that change consistent with the requirements and conditions of CDOT Reevaluation Form (#1399). The Reevaluation Form (#1399) shall be submitted to CDOT for Approval of any other Work that was not approved as a part of the Revised EA *(*See *C-470 Revised EA*, included in the Reference Documents*)*. FHWA review of Reevaluation Form (#1399) is required and typically requires at least four weeks. The FHWA review and approval must occur prior to CDOT's Approval and before the Work proposed in the Reevaluation Form #1399 can be performed. In addition, the Contractor shall be responsible for additional environmental

documentation, permits, and mitigation resulting from impacts associated with any Project change at the Contractor's expense. The Contractor shall accept responsibility for any additional schedule impacts required for the associated approvals and regulatory clearances.

5.3 Environmental Commitments and Mitigation

The Contractor shall be responsible for implementing required BMPs, minimization, and mitigation measures to minimize environmental harm from the Project.The Contractor shall minimize both environmental impacts and impacts to adjacent property owners as detailed design decisions are made. Relevant mitigation requirements shall be included in the final Design Documents or other required deliverables for the Project. The Contractor shall maintain information on the implementation to provide to CDOT upon request to inform the public and/or interested commenting agencies of the progress in carrying out the adopted mitigation measures. The Contractor's public outreach meetings and materials shall include a summary of all environmental impacts and mitigations.

5.4 Environmental Permits

The Contractor shall be responsible for obtaining all governmental and agency permits required for the Work, not otherwise obtained by CDOT, including, but not limited to, the environmental permits in Table 5-1.

No permits have been obtained by CDOT during the development of the Basic Configuration. Permits are subject to final review and approval by the Permitting Agency.

Table 5-1 Required Environmental Permits

Permits/Approvals	Permitting Agency
Municipal Separate Storm Sewer System (MS4) Discharge Permit (CDOT MS4 discharge requirements)	Colorado Department of Public Health and Environment – Water Quality Control Division
CDPHE Colorado Discharge Permit System (CDPS) storm water permit associated with construction activity	Colorado Department of Public Health and Environment – Water Quality Control Division
Clean Water Act Section 404	U.S. Army Corps of Engineers (USACE)
Clean Water Act Section 402 Construction Dewatering Permit, or Individual Construction Dewatering Permit if contaminated groundwater is expected to be encountered	Colorado Department of Public Health and Environment – Water Quality Control Division
Construction waste material and transportation of solid wastes	Colorado Department of Public Health and Environment – Hazardous Materials and Waste Management Division
Generation of contaminated materials during construction	Colorado Department of Public Health and Environment – Hazardous Materials and Waste Management Division
Notification as Resource Conservation and Recovery Act (RCRA) hazardous waste generator	Colorado Department of Public Health and Environment – Hazardous Materials and Waste Management Division
Air Pollution Emission Notice (APEN) and Construction Permit	Colorado Department of Health and Environment – Air Pollution Control Division

Stationary Source Air Quality Permit (Emissions from portable units, such as rock crushers, generators, asphalt plants, and cement plants, used during construction)	Colorado Department of Health and Environment – Air Pollution Control Division
Fugitive Dust Permit (Bridge Demolition)	Colorado Department of Public Health and Environment – Air Pollution Control Division
Asbestos Abatement Permit (Bridge Demolition)	Colorado Department of Public Health and Environment – Air Pollution Control Division
Demolition Permit (Bridge/structure Demolition)	Colorado Department of Public Health and Environment – Air Pollution Control Division
Development of Materials Management Plan with approval by the Regional Planning and Environmental Manager	Colorado Department of Transportation

Table 5-1 Required Environmental Permits (cont)

Permits/Approvals	Permitting Agency
Senate Bill 40 Certification	Colorado Parks and Wildlife
Noise Variance (as needed)	Local Municipalities
Wastewater Discharge Permit (as needed)	Local Municipalities
Conditional Letter of Map Revision (CLOMR)	Floodplain Administrator
Floodplain Development Permit	Floodplain Administrator
Letter of Map Revision	Floodplain Administrator
33 USC 408 Permission/Permit	U.S. Army Corps of Engineers

5.4.1 Municipal Separate Storm Sewer System (MS4) Permit

CDOT has obtained an MS4 Permit for the storm drainage systems that it owns and maintains. The Contractor shall be responsible for complying with the terms and conditions of the CDOT MS4 Permit that pertain to the Project. The MS4 Permit is available on the web page at http://www.coloradodot.info/programs/environmental/water-quality/documents

The Contractor shall construct permanent water quality BMPs for the Project as necessary to comply with the requirements of the CDOT MS4 Permit. Permanent water quality BMPs for the Project shall include, but are not limited to, such components as sediment basins and proprietary vaults, water quality ponds, grass roadside ditches, and grass buffer strips.

The Contractor shall immediately notify CDOT of any suspected illicit or improper connections or discharges into any storm sewer system discovered during construction of the Project.

CDOT will be responsible for investigation of the suspected illicit connection and implementing corrective action. The Contractor shall not maintain, reconnect, or otherwise allow discharge of improperly disposed materials into the storm sewer system within the limits of the Project.

See Section 12 for detailed MS4 requirements.

5.4.2 Clean Water Act, Section 404 Permit/Wetlands

A formal Jurisdictional Determination request to the U.S. Army Corps of Engineers (USACE) has not been completed for this project. The Contractor shall be responsible for developing the letter requesting the formal JD from the USACE based on proposed wetland and Waters of the U.S. impacts. The Application shall be submitted to CDOT for review and in advance of a subsequent submittal to CDOT for Approval and submittal to USACE. The request for a JD can be submitted with the Clean Water Act, Section 404 Permit Application at the Contractors discretion. The contract is responsible for all schedule implication

The Contractor shall be responsible for preparing a Clean Water Act, Section 404 Permit Application for impacts to wetlands and waters of the U.S. The Application shall be submitted to CDOT for review and in advance of a subsequent submittal to CDOT for Approval and submittal to USACE at least 45 Days before the start of construction activity which would impact wetlands or other waters of the U.S. The Contractor shall be responsible for submitting a Wetland Finding Report for temporary and permanent wetland impacts if impacts exceed the thresholds identified in the 2006 “Memorandum of Agreement” between FHWA and CDOT Regarding the Programmatic Approval of Wetland Findings”. A CDOT Functional Assessment of Colorado Wetlands (FACWet) shall be performed if a Wetland Finding is required.

Wetlands Field Identification: If the contractor proposes to impact wetlands outside the EA delineation, the Contractor shall delineate the additional project area for wetlands and Waters of the U.S.

Wetland and Waters of the U.S. Mitigation: The wetland delineation report is provided in the Biological Resources Report by CDOT in Book 3, Section 5. All permanently impacted wetlands shall be mitigated at a 1:1 ratio. The Contractor shall minimize wetland impacts as much as possible. Any required wetland mitigation shall be the responsibility of the Contractor. The Contractor shall coordinate with the USACE to comply with Section 404 permit(s) for impacts to Wetlands and Waters of the US from the project. Any additional mitigation beyond the 1:1 wetland replacement as required by the USACE shall be done in accordance with the Section 404 permit(s).

Wetlands Inspection, Establishment, Acceptance, and Warranty Period: Inspection, Landscape Establishment, Acceptance and the Landscape Warranty Period for temporary and/or permanent on-site mitigation, if the Contractors proposed not to use wetland banking option, shall be subject to the applicable requirements. Substantial Landscape Completion, Landscape Establishment Periods, and Acceptance for wetlands areas shall be subject to compliance of the requirements of all applicable permits.

The Landscape Establishment Period for wetlands areas shall commence upon receipt of a written “Notice of Substantial Landscape Completion” for wetlands areas from CDOT and is not subject to prior Final Acceptance of the Project.

The Landscape Establishment Period for wetlands areas will last for 24 months and will begin the following spring if Substantial Landscape Completion for the wetlands areas is issued in the fall.

The Contractor shall provide CDOT with annual mitigation progress reports. The reports shall be submitted to CDOT before December 31st of each year, and shall include the following:

1. Project number, Section 404-permit number, and county where project is located.
2. Summary of the status of the wetlands.
3. Percent of ground surface area that is vegetated.
4. Percent of the vegetated area that contains wetland vegetation.
5. List of prevalent plant species and their wetland establishment status.
6. Location map.
7. Drawings as needed for illustration.
8. Photographs of mitigation area for each report.
9. Percent cover of noxious weeds.
10. Acreage determination of successful mitigation sites.

Upon completion of the Landscape Establishment period for wetlands areas, at the Contractor's request, CDOT will inspect the wetlands to determine compliance to the requirements of the Contract Documents. Wetlands areas will not be accepted until a minimum of 70 percent of the mitigation site consists of wetland species and noxious weeds comprise of less than 5% of the total cover.

Acceptance of the wetlands areas will initiate the one (1) year wetlands Landscape warranty period and maintenance period. Throughout the wetlands landscape warranty and maintenance period the Contractor shall be responsible for remedial action and restoration of created wetlands.

Remedial action is defined action taken to correct failed wetland construction. This can include but is not limited to:

1. Re-evaluation of hydrology source.
2. Groundwater monitoring to identify and correct improper grade elevations.
3. Additional excavation or fill.
4. Replanting vegetation.

Restoration of created wetlands is defined as actions taken to improve the conditions of an existing wetland that has limited functions. Techniques can include, but are not limited to:

1. Replanting vegetation.
2. Re-configuration of improper ground elevation
3. Enhancing hydrology.

5.4.3 Construction Dewatering Permit

The Contractor shall obtain a Construction Dewatering Permit from the CDPHE for any dewatering of groundwater during construction in accordance with Water Quality Control Division (WQCD) requirements. The Contractor shall apply for this permit at least 30 Days prior to the start of discharge Activities.

The Contractor shall provide all information needed to assist the WQCD in their evaluation and setting of a water quality standard for this permit, which may include monitoring of the discharged water.

The Contractor shall monitor for any settlement caused by dewatering. The Contractor shall conduct a preliminary survey of any private property or buildings that may be affected by dewatering to establish existing conditions. The Contractor shall repair any damage caused by dewatering operations.

The Contractor shall construct settling ponds for effluent from dewatering operations, as required by the Construction Dewatering Permit.

All costs for dewatering Work shall be the obligation of the Contractor.

5.4.4 Senate Bill 40/ Wildlife

The Contractor shall comply with the General and Special Conditions provided in the April 2013 "Guidelines for Senate Bill 40 Wildlife Certification" developed and agreed upon by the Colorado Division of Wildlife and the Colorado Department of Transportation.

The Contractor shall prepare an application for a formal Wildlife Certification to Colorado Parks and Wildlife (CPW) for activities in riparian areas that are subject to Colorado Senate Bill-40 (SB-40). After CDOT's Approval, CDOT will submit the application to CPW at least 60 days prior to planned construction or maintenance Activities to allow 30 days for CPW review of the submitted documents and 30 days for follow-up coordination, if required.

CPW will complete its review of the application and issue SB-40 Certification or request additional information or mitigation commitments within 30 days of final submittal. The Contractor shall submit its application so as to allow CDOT sufficient time to complete these activities.

5.4.5 Floodplain Development Permit, Conditional Letter of Map Revision, Letter of Map Revision

Any work within regulatory floodplains will require a Floodplain Development Permit from the jurisdiction within which the improvements are proposed. The permits may require review and approval by adjacent jurisdictions or other agencies. Refer to Section 12 for more details

5.4.6 Colorado Discharge Permit System, Stormwater Construction Permit (CDPS-SCP)

Project construction activities will disturb more than an acre of land and thus will need to be covered under a Stormwater Construction Permit according to the Colorado Discharge Permit System. See Section 12 where the CDPS-SCP is discussed more fully.

5.4.7 USACE Section 408 Permit

CDOT and FHWA have coordinated with the US Army Corps of Engineers (USACE) regarding application of the Section 408 process on the C-470 Express Lanes project. Section 408 will apply to the portion of the project occurring within CDOT's C-470 easement on property owned by the USACE, from roughly Santa Fe Drive to Wadsworth Boulevard. The 33 U.S.C. § 408

(Section 408) provides that any proposed modification to an existing USACE project must obtain permission from the Corp by demonstrating that such proposed alteration or permanent use and occupation of the Federal flood control project is "not injurious to the public interest and will not impair the usefulness of such work."

CDOT and FHWA have worked with the USACE Omaha District to clarify the requirements and develop guidance for implementing the Section 408 process on the C-470 Express Lanes project. Included in the Reference Documents is EC 1165-26-216 that describes in detail the procedures and steps for Section 408 to be completed. The C-470 Express Lane project is currently in Step 3 of the Section 408 process. These discussions have identified the following:

- USACE Omaha District will provide the final Section 408 decision. The final submittal package must include 100% design plans and specifications for the referenced area.
- The USACE Section 408 final review, approval and signature process is estimated to take approximately 6 months from the submittal of 100% design plans for the referenced area.
- C-470 Express Lanes project construction within the referenced area cannot proceed until Section 408 approval is obtained.
- USACE Denver Regulatory Office will not issue any required Section 404 Permits for the referenced area within the C-470 Express Lanes project until Section 408 approval is obtained.
- USACE Denver Regulatory Office will issue required Section 404 Permits for portions of the project outside of the referenced area upon completion of final design and approval of permit applications for those areas.

  Required documentation for Step 3:

- Section 408 review may begin with USACE at 60% design plans, specifications, and supporting technical analysis to initiate the Section 408 review process. The contractor will coordinate this review with the USACE through final design. Any and all proposed construction activities within the USACE's right-of-way (CDOT C-470 easement) will need to be included in the review process.
- Subsurface drainage analysis, at a minimum, shall be focused from STA 795+00 to 908+00, approximately Massey Draw to Platte River Bridge. USACE has indicated subsurface drainage in this area daylights to the existing slopes, creating erosion potential in the roadway embankment and beyond. The Contractor shall positively address this condition with the design.
- Plans should include drainage, grading, culverts, bridge and any other elements that have the potential to increase the drainage design.
- C-470 over the Platte River
    - The design standard is a no rise situation. Analysis should be done with HEC-RAS.
    - A Hydrologic and Hydraulics System Performance Analysis must be performed to determine impacts of the proposed alteration. See Appendix F of the

USACE's EC 1165-26-216. For this analysis use the 5000 cfs authorized capacity. For information purposes also provide the 8000cfs analysis.

- As provided in Book 2, Section 13, the Contractor shall have coordinated with the local Floodplain Administrator in processing a CLOMR for the design.

- Maps shall be provided clearly defining the existing real estate rights. The Work shall be contained entirely within the existing CDOT C-470 easement. CDOT will not obtain additional easement footprint for the Work.
- Submit sufficient information so that the USACE can conduct its analysis in accordance with ER 1165-2-26, provided in the Reference Documents. In order to facilitate the USACE's review, all of the steps within the ER 1165-2-26 should be clearly listed and in order.

5.5 Deliverables

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

Table 5-2 Deliverables Review, Approval and/or Acceptance

Deliverable	Review Acceptance or Approval	Schedule
Draft Environmental Compliance Work Plan	Review	Within 30 days of NTP 1
Final Environmental Compliance Work Plan	Approval	Prior to issuance of NTP 2
Environmental Compliance Work Plan Addendums	Acceptance	Monthly
Environmental Compliance Work Plan Update	Acceptance	Every 6 months
Completed Environmental Compliance Work Plan	Approval	As a condition for Final Project Acceptance
Construction Air Quality Plan and Fugitive Dust Control Plan	Acceptance	Prior to issuance of NTP 2
Preliminary Noise Technical Report	Acceptance	Prior to Benefitted Receptor Surveys
Benefitted Receptor Survey Plan	Approval	14 days prior to Executing Benefitted Receptor Survey
Final Noise Technical Report	Acceptance	As part of the Final RFC Documents submittal
Revised Noise Barrier or Structure Elevations	Acceptance	As part of the Final RFC Documents submittal
Construction Noise and Vibration Mitigation Plan	Acceptance	As part of the Final RFC Documents submittal
Plans for construction Activities which may impact the Denver Formation - Paleontology	Review	14 days prior to associated activities
Native Seed Mix	Review / Acceptance	With the Pre-Released for Construction (RFC) Review Documents submittals and the Final RFC Documents submittals
Trail Closure and Detour Communication Plan	Approval	No later than 30 days prior to trail closure
Trail Detour Signing Plan	Approval from CDOT, SSPRD, and HRMD	14 days prior to detour execution

Deliverable	Review Acceptance or Approval	Schedule
90% Construction Plans for Riparian Impact Areas	Acceptance	Required for submittal of SB 40 permit that must be obtained prior to construction in riparian impact areas
Landscape and Plant Establishment Plan for Riparian Areas	Approval	Prior to commencing landscaping of riparian areas
Contractor Biologist Education and Experience	Acceptance	30 days prior to beginning any work required by Biologist
BTPD Management Plan	Approval	Prior to impacting BTPD areas
Migratory Bird Nest Survey	Review	Prior to impacting existing structures, trees, or disturbing soils that may contain active bird nests during the acting active nesting seasons.
Materials Management Plan (MMP) including Sampling Analysis Plan (SAP)	Approval	Prior to issuance of NTP 2 with quarterly reports thereafter.
Remediation Scope of Work	Approval	Prior to commencing Remediation Work
Draft Health and Safety Management Plan (HASP) and Spill Prevention Control and Countermeasures (SPCC) Plan	Review	30 days after NTP1
Health and Safety Management Plan (HASP)	Acceptance	Prior to issuance of NTP 2.
Identification of Subcontractors to Perform Remediation Work	Review	Prior to subcontractors Commencing Remediation Work
Spill Prevention Control and Countermeasures (SPCC)	Acceptance	Prior to issuance of NTP 2.
Monthly RHM Reports	Review	Monthly
Quarterly Summary of Hazardous Materials Management	Review	Quarterly
Wetland Mitigation Plan	Acceptance	Prior to issuance of Released for Construction Documents. Only required if on-site mitigation is constructed
Annual Wetlands Mitigation Progress Reports	Acceptance	Prior to December 31 of every year. Only required if on-site mitigation is constructed
Floodplain Development Permit(s)	Review	See Section 12
Colorado Discharge Permit System, Stormwater Construction Permit (CDPS-SCP)	Acceptance	Prior to commencing construction, expected in phases or packages

Deliverable	Review Acceptance or Approval	Schedule
USACE Section 408 Permit	Approval	Prior to commencing construction within USACE property.
Environmental Permits	Acceptance	Per the requirements of the permit and the Contract Documents.
Burrowing Owl Survey	Acceptance	1 week prior to disturbance
Hazardous Substance Documents/Records	Review	Once Work Initiated
NAD Documentation	Review/Acceptance/Approval	If Required
CDOT Reevaluation Form (#1399)	Approval	Only if Required/Prior to Start of Construction
404 Application and Permit	Review/Approval	45 days prior to the start of Construction

All deliverables shall also conform to the requirements of Section 3, Quality Management.

5.6 Prairie Dog Policy

MEMORANDUM

DEPARTMENT OF TRANSPORTATION
Russell George
Executive Director
4201 E. Arkansas Avenue, Room 262
Denver, CO 80222
(303) 757-9201

DOT
DEPARTMENT OF TRANSPORTATION

DATE: January 15, 2009

TO: RTDs & RPEMs

FROM: Russell George, Executive Director

SUBJECT: **IMPACTED BLACK-TAILED PRAIRIE DOG POLICY**

On December 3, 2008 the RTDs reviewed and approved a change to CDOT's prairie dog policy. The change eliminated the requirement to notify and receive approval from the Food and Drug Administration (FDA) prior to relocating prairie dogs. Since FDA no longer requires such a notification, the policy has been amended to reflect the change. All other provisions of the policy remain unchanged.

Over the winter of 2004-2005 the Chief Engineer, RPEMs, and RTDs agreed upon the following policy for addressing Black-tailed prairie dogs that will be impacted by CDOT projects. These guidelines should be applied to all CDOT activities that affect Black-tailed prairie dogs.

1) CDOT projects will be designed and constructed to avoid and minimize impacts to prairie dog colonies greater than two acres in area;

2) If a colony is less than two acres, but has the potential to expand into areas that are currently inactive (i.e., not constrained), the available and accessible habitat will be the determining size of the area to be considered;

3) In order to foster a heightened sense of CDOT's ecological stewardship by the public, projects involving towns less than two acres in area, will be designed and constructed to avoid and minimize impacts, which may include the relocation of prairie dogs, so long as doing so will not increase the impacts to other resources (e.g. wetlands, historical properties, environmental justice issues, archeological sites, etc.) and is not cost prohibitive;

4) The area of prairie dog towns that will be affected by a project will be calculated before construction begins;

5) Relocation efforts for prairie dog town greater than two acres shall be conducted in accordance with CRS 35-7-203, as well as any other applicable laws or regulations;

6) If a relocation site cannot be located for towns larger than two acres, the prairie dogs will be captured and donated to raptor rehabilitation facilities, or turned over the FWS for the black-footed ferret reintroduction program;

7) At no time will CDOT authorize earth-moving activities that result in the burying of living prairie dogs. If needed, humane techniques for the killing of prairie dogs within a town < 2 acres in size, will be obtained from CDOW;

8) Coordination with the Colorado Division of Wildlife's District Wildlife Manager whose area the project is in, will be initiated before any manipulation of prairie dogs or their colonies begins;

The matrix below outlines the steps and the order they are to be taken based on the preconstruction area of an affected prairie dog town.

Preconstruction area of available prairie dog habitat[1]

	greater than 2 acres	less than two acres
1st	Avoid and minimize impacts	Avoid and minimize impacts
2nd	Relocate	Donate to ferret program and/or raptor rehab program
3rd	Donate to ferret program and/or raptor rehab program	Humanely euthanize[2]
4th	Humanely euthanize[2]	-------

1. Area of land able to be used by prairie dog that may or may not be occupied; calculated before a project begins.

2. Aluminum phosphate capsules, carbon monoxide gas cartridges or carbon dioxide gas cartridges are currently recommended, but not the exclusion of any future technologies that may be developed.

Background

On February 4, 2000 the United States Fish and Wildlife Service (USFWS) classified the black-tailed prairie dog as a candidate species for protection under the Endangered Species Act. In October of that same year the State of Colorado designated the black-tailed prairie dog a Species of Concern.

On January 8, 2002 CDOT Executive Director Tom Norton signed a memo outlining guidelines for the relocation of black-tailed prairie dogs impacted by CDOT activities. Subsequently, the USFWS has removed the black-tailed prairie dog from the federal candidate species list. However, the State of Colorado has retained it on their list of species of concern.

It is important that CDOT adopt a statewide strategy that will assist in diminishing the negative effects that transportation related activities have on the continued survival and recovery of the species. Adopting a pro-active departmental policy under the authority of CDOT may help minimize the possibility of federal listing of the black-tailed prairie dog in the future and is consistent with State and Transportation Commission policy direction.

Policy Basis
The Transportation Commission has adopted policy statements and policy statements and policy guidance in the 2020 Statewide Transportation Plant adopted November 2000, that direct CDOT activities. These include:

"Statewide Transportation Policy on the Environment:
CDOT will promote a transportation system that is environmentally responsible and encourages preservation of the natural and enhancement of the created environment for current and future generations. We will incorporate social, economic, and environmental concerns into the planning design, construction, maintenance and operations of the states existing and future transportation system. With the active participation of the general public, federal, state and local agencies, we will objectively consider all reasonable alternatives to avoid or minimize adverse impacts."

and:

"Environmental Policy Guidance:
The Transportation Commission supports pro-active techniques to mitigate impacts of the transportation system on the environment by developing creative strategies that:

- Comprehensively address anticipated environmental impacts of the state transportation system.
- Consider project enhancements in affected communities in a cost effective manner consistent with the mission of the Department; and
- Expedite project development."

This policy memo will be included in to the NEPA Guidance Manual. You can find the Manual at: http://www.dot.state.co.us/environmental/Manual/NepaManual.asp; the memo will be in Chapter 9, Section 9.8.

5.7 Project Special Provisions

REVISION OF SECTION 240
BLACK-TAILED PRAIRIE DOG MANAGEMENT (WESTERN BURROWING OWL)

Section 240 of the Standard Specification is hereby added for this project as follows:

DESCRIPTION

Subsection 240.01 shall include the following: This work shall consist of protecting Black-tailed Prairie Dogs. The Contractor shall coordinate clearing and grubbing operations to avoid impacts to the Black-tailed Prairie Dog.

MATERIALS

240.02 The Contractor shall furnish all material and equipment of sufficient type and size to complete the BTPD management.

CONSTRUCTION REQUIREMENTS

Subsection 240.03 shall include the following:

Prairie dog colonies are known to occur on or adjacent to CDOT ROW within the project area, as shown on the Environmental Plan Sheets. A minimum of 10 business days prior to any work in areas with Prairie Dog colonies, the Contractor shall notify the CDOT Project Engineer, that a Prairie Dog survey will be performed by a qualified biologist. Results of the survey will be provided to the CDOT Project Engineer and approved prior to work in the area. Should active Prairie Dog colonies be found, from approximately July 1 to March 15 (mid-summer to mid-spring), a CDOT Project Engineer designated qualified biologist shall assist the contractor in passive relocation of prairie dogs, if construction cannot avoid the prairie dog colony. During the pupping season from approximately March 15 to July 1 (mid-spring to mid-summer), as determined by the CDOT Project Engineer designated qualified biologist, disturbance of Prairie Dog colonies will not be allowed. No staging of equipment, vehicles, or materials will be allowed within any prairie dog colony at any time.

Passive Relocation method:

The Contractor shall install silt fences in a manner that creates a rectangular enclosure that limits the prairie dogs field of view. These enclosures will be constructed as to avoid blocking access to residences. Silt fence shall be entrenched to a depth of 6 inches.

Phase I: Silt fence is to be installed parallel to the highway at the minimum distance necessary for ground disturbance in the wok area where prairie dogs are present, but not to exceed the limits of disturbance shown on the plans. Should the planned disturbance exceed the limits of disturbance shown on the plans, relocation methods other than passive relocation may be necessary at the discretion of the CDOT qualified biologist to include live trapping or other means.

Phase II: Grade the area between the silt fence and highway to depth of 6 inches.

Phase III: Install silt fence 5 feet off the edge of existing oil in the same areas fenced in Phase I. Perpendicular fencing may be installed, as recommended by the qualified biologist, to reduce prairie dog sight distance within each enclosure.

Phase IV: Re-grading of the area should occur as necessary (i.e. at least once a day) until the prairie dogs have left the work area (approximately 3 days). Once the contractor no longer sees any evidence of the prairie dogs in the work area (i.e. prairie dogs or new burrows), they shall call the qualified biologist to resurvey the area so a final clearance can be given.

Exclusion during the pupping season:

If construction occurs between March 15-July 1 (within the prairie dog "pupping" season, as determined by the qualified biologist), no work will be allowed within any active prairie dog colonies.

The qualified biologist shall assist the contractor in locating and installing barrier fencing (silt fencing) to protect active prairie dog colonies from construction activities during the "pupping" season (March 15-July 1).

Work in adjacent to prairie colonies. Prairie dog colonies are known to occur in or adjacent to CDOT ROW within the project area, as shown on the Environmental Plan Sheets. Western burrowing owls occupy prairie dog colonies. Therefore any work occurring within these limits during the nesting season (March 15-October 31) will require a burrowing owl survey prior to work commencing. A minimum of 10 business days prior to any work in areas with Prairie Dog colonies, the Contractor shall notify the CDOT Project Engineer, that a Western Burrowing Owl Survey will be performed by a qualified biologist. Results of the survey will be provided to the CDOT Project Engineer and approved prior to work in the area. If prairie construction activities are initiated during the nesting season for burrowing owls (March 15 to October 31), a burrowing owl survey is required. If burrowing owls are identified, the qualified biologist shall assist the Contractor in locating and installing safety barrier fencing (silt fencing) within 150 feet o the work zone to protect active burrows from construction activities during the nesting season (March 15-October 31). Work shall not proceed within the 150 foot buffer until the young have fledged or the nests have become inactive.

Contractor shall contact CDOT Environmental Manager one week prior to onsite prairie dog management. If prairie dog trapping is required, the Contractor shall also contact the CDOT Project Engineer and CDOT Region 1 Public Relations 30 days prior to onsite prairie dog management.

REVISION OF SECTION 240
BLACK-TAILED PRAIRIE DOG MANAGEMENT (WESTERN BURROWING OWL)

Section 240 of the Standard Specification is hereby added for this project as follows:

DESCRIPTION

Subsection 240.01 shall include the following: This work shall consist of protecting Black-tailed Prairie Dogs. The Contractor shall coordinate clearing and grubbing operations to avoid impacts to the Black-tailed Prairie Dog.

MATERIALS

240.02 The Contractor shall furnish all material and equipment of sufficient type and size to complete the BTPD management.

CONSTRUCTION REQUIREMENTS

Subsection 240.03 shall include the following:

Prairie dog colonies are known to occur on or adjacent to CDOT ROW within the project area, as shown on the Environmental Plan Sheets. A minimum of 10 business days prior to any work in areas with Prairie Dog colonies, the Contractor shall request, through the CDOT Project Engineer, that a Prairie Dog survey be performed by a qualified biologist. Should active Prairie Dog colonies be found, from approximately July 1 to March 15 (mid-summer to mid-spring), a CDOT Project Engineer designated qualified biologist shall assist the contractor in passive relocation of prairie dogs, if construction cannot avoid the prairie dog colony. During the pupping season from approximately March 15 to July 1(mid-spring to mid-summer), as determined by the CDOT Project Engineer designated qualified biologist, disturbance of Prairie Dog colonies will not be allowed. No staging of equipment, vehicles, or materials will be allowed within any prairie dog colony at any time.

Passive relocation method:

The Contractor shall install silt fences in a manner that creates a rectangular enclosure that limits the prairie dogs field of view. These enclosures will be constructed as to avoid blocking access to residences. Silt fence shall be entrenched to a depth of 6 inches.

Phase I: Silt fence is to be installed parallel to the highway at the minimum distance necessary for ground disturbance in the work area where prairie dogs are present, but not to exceed the limits of disturbance shown on the plans. Should the planned disturbance exceed the limits of disturbance shown on the plans, relocation methods other than passive relocation may be necessary at the discretion of the CDOT qualified biologist to include live trapping or other means.

Phase II: Grade the area between the silt fence and highway to a depth of 6 inches.

Phase III: Install silt fence 5 feet off the edge of existing oil in the same areas fenced in Phase I. Perpendicular fencing may be installed, as recommended by the qualified biologist, to reduce prairie dog sight distance within each enclosure.

Phase IV: Re-grading of the area should occur as necessary (i.e. at least once a day) until the prairie dogs have left the work area (approximately 3 days). Once the contractor no longer sees any evidence of prairie dogs in the work area (i.e. prairie dogs or new burrows), they shall call the qualified biologist to resurvey the area so a final clearance can be given.

Exclusion during the pupping season:

If construction occurs between March 15 – July 1 (within the prairie dog "pupping" season, as determined by the qualified biologist), no work will be allowed within any active prairie dog colonies.

The qualified biologist shall assist the contractor in locating and installing barrier fencing (silt fencing) to protect active prairie dog colonies from construction activities during the "pupping" season (March 15 - July 1).

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REVISION OF SECTION 240
BLACK-TAILED PRAIRIE DOG MANAGEMENT (WESTERN BURROWING OWL)

Work in adjacent to prairie dog colonies. Prairie dog colonies are known to occur in or adjacent to CDOT ROW within the project area, as shown on the Environmental Plan Sheets. Western burrowing owls occupy prairie dog colonies. Therefore any work occurring within these limits during the nesting season (March 15 – October 31) will require a burrowing owl survey prior to work commencing. A minimum of 10 business days prior to any work in areas with Prairie Dog colonies, the Contractor shall request, through the CDOT Project Engineer, that a Western Burrowing Owl Survey be performed by a qualified biologist. If prairie construction activities are initiated during the nesting season for burrowing owls (March 15 to October 31), a burrowing owl survey is required. If burrowing owls are identified, the qualified biologist shall assist the Contractor in locating and installing safety barrier fencing (silt fencing) within 150 feet of the work zone to protect active burrows from construction activities during the nesting season (March 15 – October 31). Work shall not proceed within the 150 foot buffer until the young have fledged or the nests have become inactive.

Contractor shall contact CDOT Environmental Manager one week prior to onsite prairie dog management. If prairie dog trapping is required, the Contractor shall also contact the CDOT Project Engineer and CDOT Region 2 Public Relations 30 days prior to onsite prairie dog management.

240.03 Measurement and Payment

Measurement and payment for Prairie Dog Management will be paid for under the items F/A – Prairie Dog Management (Burrowing Owl). Included in the items is all labor, materials, and equipment and permits required to complete the work.

Applying for and obtaining permits, hiring licensed specialists, trapping, transporting, euthanizing, parasite and disease management (including pesticides and other chemicals), and all other activities necessary to properly remove the BTPD in accordance with all of the requirements of the CDOT BTPD policy will not be measured and paid for separately, but shall be included in the work.

Partial payments for Prairie Dog management will made according to the following schedule:

-50 percent of the bid amount will be paid on the first pay request that work associated with Prairie Dog Management is required for construction

-When 50 percent of the original contract amount is earned, 75 percent of the bid amount will be paid

-100 percent of the bid amount will be paid on the final pay request upon request acceptance

Payment will be made under:

Pay Item	Pay Unit
F/A – Prairie Dog Management (Burrowing Owls)	F.A.

SECTION 240

PROTECTION OF MIGRATORY BIRDS

BIOLOGICAL WORK PERFORMED BY THE CONTRACTOR'S BIOLOGIST

Section 240 is hereby added to the Standard Specifications for this project as follows:

DESCRIPTION

240.01 This work consists of protecting migratory birds during construction.

MATERIALS AND CONSTRUCTION REQUIREMENTS

240.02 The Contractor shall schedule clearing and grubbing operations and work on structures to avoid taking (pursue, hunt, take, capture or kill; attempt to take, capture, kill or possess) migratory birds protected by the Migratory Bird Treaty Act (MBTA). The Contractor shall retain a qualified wildlife biologist for this project. The wildlife biologist shall have a minimum of three years experience conducting migratory bird surveys and implementing the requirements of the MBTA. The Contractor shall submit documentation of the biologist's education and experience to the Engineer for acceptance. A biologist with less experience may be used by the Contractor subject to the approval of the Engineer based on review of the biologist's qualifications.

The wildlife biologist shall record the location of each protected nest, bird species, the protection method used, and the date installed. A copy of these records shall be submitted to the Engineer.

(a) *Vegetation Removal.* When possible, vegetation shall be cleared prior to the time when active nests are present. Vegetation removal activities shall be timed to avoid the migratory bird breeding season which begins on April 1 and runs to August 31. All areas scheduled for clearing and grubbing between April 1 and August 31 shall first be surveyed within the work limits for active migratory bird nests. The Contractor's wildlife biologist shall also survey for active migratory bird nests within 50 feet outside work limits. Contractor personnel shall enter areas outside CDOT right of way only if a written, signed document granting permission to enter the property has been obtained from the property owner. The Contractor shall document all denials of permission to enter property. The Contractor shall avoid all active migratory bird nests. The Contractor shall avoid the area within 50 feet of the active nests or the area within the distance recommended by the biologist until all nests within that area have become inactive. Inactive nest removal and other necessary measures shall be incorporated into the work as follows:

1. *Tree and Shrub Removal or Trimming.* Tree and shrub removal or trimming shall occur before April 1 or after August 31 if possible. If tree and shrub removal or trimming will occur between April 1 and August 31, a survey for active nests shall be conducted by the wildlife biologist within the seven days immediately prior to the beginning of work in each area of tree and shrub removal or trimming. The survey shall be conducted for each phase of tree and shrub removal or trimming.

   If an active nest containing eggs or young birds is found, the tree or shrub containing the active nest shall remain undisturbed and protected until the nest becomes inactive. The nest shall be protected by placing fence (plastic) a minimum distance of 50 feet from each nest to be undisturbed. This buffer dimension may be changed if determined

appropriate by the wildlife biologist and approved by the Engineer. Work shall not proceed within the fenced buffer area until the young have fledged or the nests have become inactive.

If the fence is knocked down or destroyed by the Contractor, the Engineer will suspend the work, wholly or in part, until the fence is satisfactorily repaired at the Contractor's expense. Time lost due to such suspension will not be considered a basis for adjustment of time charges, but will be charged as contract time.

2. *Grasses and Other Vegetation Management.* Due to the potential for encountering ground nesting birds' habitat, if work occurs between April 1 and August 31, the area shall be surveyed by a wildlife biologist within the seven days immediately prior to ground disturbing activities.

The undisturbed ground cover to 50 feet beyond the planned disturbance, or to the right of way line, whichever is less, shall be maintained at a height of 6 inches or less beginning April 1 and continuing until August 31 or until the end of ground disturbance work, whichever comes first.

If birds establish a nest within the survey area, an appropriate buffer of 50 feet will be established around the nest by the CDOT biologist. This buffer dimension may be changed if determined appropriate by the CDOT biologist and approved by the Engineer. The Contractor shall install fence (plastic) at the perimeter of the buffer. Work shall not proceed within the buffer until the young have fledged or the nests have become inactive.

If the fence is knocked down or destroyed by the Contractor, the Engineer will suspend the work, wholly or in part, until the fence is satisfactorily repaired at the Contractor's expense. Time lost due to such suspension will not be considered a basis for adjustment of time charges, but will be charged as contract time.

(b) *Raptors.* The wildlife biologist shall conduct raptor nest surveys within 0.5 mile of the construction site prior to the start of construction and prior to each construction phase. This survey can be done with binoculars. If construction activities are located within the Colorado Division of Wildlife (CDOW) recommended buffer zone for specific raptors, "NO WORK" zones shall be established around active sites during construction according to the CDOW standards or as recommended by the wildlife biologist in consultation with the CDOW. The "NO WORK" zone shall be marked with either fencing or signing. Work shall not proceed within a "NO WORK" zone until the wildlife biologist has determined that the young have fledged or the nest is unoccupied.

If it is determined that raptor perches will be affected, the Contractor shall install perch poles, made from 2 inch round steel sign posts with 24-inch T brackets without sign mounting holes. The poles shall be at least 12 feet in height.

(c) *Work on structures*. The Contractor shall prosecute work on structures in a manner that does not result in a taking of migratory birds protected by the Migratory Bird Treaty Act (MBTA). The Contractor shall not prosecute the work on structures during the primary breeding season, April 1 through August 31, unless he takes the following actions:

(1) The Contractor shall remove existing nests prior to April 1. If the Contract is not awarded prior to April 1 and CDOT has removed existing nests, then the monitoring of nest building shall become the Contractor's responsibility upon Notice to Proceed.

(2) During the time that the birds are trying to build or occupy their nests, between April 1 and August 31, the Contractor shall monitor the structures at least once every three days for any nesting activity.

(3) If the birds have started to build any nests, they shall be removed before the nest is completed. Water shall not be used to remove the nests if nests are located within 50 feet of any surface waters.

(4) Installation of netting may be used to prevent nest building. The netting shall be monitored and repaired or replaced as needed. Netting shall consist of a mesh with openings that are ¾ inch by ¾ inch or less.

If an active nest become established, i.e., there are eggs or young in the nest, all work that could result in abandonment or destruction of the nest shall be avoided until the young have fledged or the nest is unoccupied as determined by the wildlife biologist and approved by the Engineer. The Contractor shall prevent construction activity from displacing birds after they have laid their eggs and before the young have fledged.

If the project continues into the following spring, this cycle shall be repeated. When work on the structure is complete, the Contractor shall remove and properly dispose of netting used on the structure.

(c) *Taking of a Migratory Bird.* The taking of a migratory bird shall be reported to the Engineer. The Contractor shall be responsible for all penalties levied by the U. S. Fish and Wildlife Service (USFWS) for the taking of a migratory bird.

6.0 THIRD-PARTY AGREEMENTS

The Contractor shall be responsible for obtaining third-party approvals required to complete the Work, except as otherwise specified in the Contract Documents. Third-party coordination and approvals will be required from, but not limited to, the following agencies: Douglas County, Arapahoe County, Jefferson County, Lone Tree, Highlands Ranch Metro District, Littleton, the Burlington Northern Santa Fe Railway (BNSF), the Union Pacific Railroad (UPRR), and the Regional Transportation District (RTD). Utility Company requirements are addressed in the Book 2, Section 7 Utility Relocations. Coordination and approval requirements of Local Agencies are addressed in this Section.

6.1 Third-Party Agreements Associated with this Project

6.1.1 CDOT Executed Agreements

CDOT will be entering into Agreements with other entities for this project. These agreements are being executed separate from the Contract. Any requirements made necessary from these agreements are provided in Contract Documents. These agreements include:

An Inter-Governmental Agreement (IGA) between the Colorado Department of Transportation and Douglas County for drainage improvements to be completed as part of this Project.

An Inter-Governmental Agreement (IGA) between the Colorado Department of Transportation and Highlands Ranch Metro District for drainage improvements to be completed as part of this Project.

6.1.2 Contractor Associated Agreements

The Contractor shall be required to execute the Work as provided herein to facilitate execution of agreements with other Third Parties. Those agreements include:

<u>BNSF</u>
CDOT has obtained a Consent-to-Maintain approval from the BNSF for the improvements required within BNSF right-of-way, provided the Work does not modify the rail facilities. CDOT will provide the formal approval letter to the successful proposer following award. The Contractor shall coordinate with the BNSF to meet the requirements of the Consent-to-Maintain to execute the Work on BNSF right-of-way. A new C&M Agreement will not be executed with the BNSF

A Contractor's Right-of-Entry agreement between the Contractor and the BNSF shall be executed by the Contractor.

<u>UPRR</u>

CDOT has obtained a Consent-to-Maintain approval from the UPRR for the improvements required within UPRR right-of-way, provided the Work does not modify the rail facilities. CDOT will provide the formal approval letter to the successful proposer following award. The Contractor shall coordinate with the UPRR to meet the requirements of the Consent-to-Maintain to execute the Work on UPRR right-of-way. A new C&M Agreement will not be executed with the UPRR.

Preliminary engineering review agreement between the Contractor and the UPRR shall be executed by the Contractor only if modifications to the rail facilities are proposed by the Contractor.

A Contractor's Right-of-Entry agreement between the Contractor and the UPRR shall be executed by the Contractor.

RTD
RTD Light Rail Right of Way Access Request / Permit

6.2 Local Agency

Local Agency requirements pertaining to the Project are detailed in Book 2, Book 3 and Reference Documents as appropriate.

6.3 Railroads

Railroad shall refer to the BNSF and/or the UPRR for the requirements necessary to complete the Work.

The Project includes Work under and adjacent to the UPRR easement properties and the BNSF easement properties (Railroad ROW) under or adjacent to the tracks, wire lines, and other facilities of the Railroad. This Section provides requirements applicable to Work performed under or adjacent to the Railroad ROW. Anticipated Work under or adjacent to Railroad ROW is limited to construction Work necessary for the reconstruction and widening of C-470 and associate ramps, including all Work necessary. The Contractor shall abide by and comply with the requirements of the Railroad, as well as those requirements specified herein and as identified in the Consent-to-Maintain letter.

Until such time as the Contractor has executed required agreements with the Railroads, the Contractor and any member of its team shall maintain a No Work Zone within 50 feet of each overhead railroad bridge structure, and develop their phasing and work schedule accordingly. The Contractor shall process the Right-of-Entry directly with each railroad, and submit any and all necessary paperwork directly to each railroad, including, but not limited to required insurance certificates and railroad contracts, to obtain written authorization from each railroad that construction work associated with this project under the railroad bridges may begin. Contractor shall provide copies of all correspondence between Contractor and railroads to the CDOT Project Manager, including executed Right-of-Entry from each railroad, prior to the start of contractor's activities within 50 feet of each overhead railroad bridge.

The Contractor shall comply with all rules and regulations prescribed by the Railroad as to the proper manner of protecting the tracks (and the traffic moving thereon), telephone, telegraph and signal wires, and other property of the Railroad or their tenants at and in the vicinity of the Project during the time such Work is being performed. Compliance with the Railroad rules and regulations shall include execution of any agreements required by the Railroad.

6.3.1 Applicable Standards

The design and construction of any Railroad Work (Work modifying or affecting the Railroad facilities during construction or permanently modifying the Railroad facilities) for the Project shall be in accordance with the Railroad's written specifications, standards of practice (which may include design format), and construction methods that are current at the Proposal Due Date. The Contractor shall obtain all such written specifications, standards of practice, and construction methods from the Railroad.
In the event of a conflict between the requirements of the Railroad and the requirements of the Contract Documents, CDOT, at its sole discretion, will determine which shall govern. The Contractor shall be responsible for resolution of any unresolved ambiguity prior to proceeding with any Railroad Work.

The Contractor shall meet the requirements included in the Consent-to-Maintain letter, existing Railroad agreements, and permits entered into by the Contractor for Work to be performed by the Contractor within Railroad ROW.

6.3.2 Administrative Requirements

Within 5 Days after NTP1, the Contractor shall notify the Railroad(s):

UPRR
Sherman Spear
Manager of Industry & Public Projects
Union Pacific Railroad Company
1400 West 52nd Avenue
Denver, CO
Office: 303-405-5039
Email: snspear@up.com

BNSF
Bentley Tomlin
Manager Public Projects-CO, NE, and WY
BNSF Railway
4515 Kansas Ave
Kansas City, KS 66106
Office: 913-551-4964

The Contractor shall meet with the Railroad and CDOT as soon as practicable after NTP1 to review all Railroad points of concern and other items that may affect the Schedule. The

Contractor shall identify critical Activities and sequences as they affect Railroad operations, and shall plan to effectively mitigate Railroad impacts.

Before commencing any work on Railroad property, the Contractor shall enter into right of entry agreements with the Railroad and comply with the Railroad procedures for the agreement.

All costs associated with applying for and complying with Railroad permits or agreements, including required insurance coverage, clerical, administrative, and handling expenses in connection with the processing of these agreements, shall be included in the Work.

6.3.2.1 Railroad Insurance

The Contractor shall comply with the provisions for Railroad insurance as specified in the executed agreement with the Railroad and in the terms and conditions of the Contract.

6.3.2.2 Flagging and Inspection

Any Work within, or Work Equipment that could potentially fall within, 25 feet of the centerline of the nearest track rail shall require a Railroad flagger. The Contractor shall notify the Railroad per the executed agreement with the Railroad to arrange for required flagging services. The Railroad flagger shall provide services for the Railroad only. The Contractor shall provide a 30 day advance notice to the Railroad for the need of Railroad flagger services. Once the Contractor requests a flagger for Work on Railroad ROW, the flagger shall remain for the entire duration of the Work on Railroad ROW. The Contractor shall be responsible to appropriately notify the Railroad regarding flagging start and end dates for Work on the Railroad ROW. The Contractor shall provide a 15 day advance notice to the Railroad when all Work on the Railroad ROW is scheduled for completion to provide for termination of Railroad flagger services. During the period of construction, all flagging and protective services shall be performed strictly in accordance with directives and instructions issued by the Railroad. The Contractor shall confer with the Railroad for the times, locations, and manner of such protective measures. The Contractor shall include the Railroad flaggers in all its regularly scheduled safety meetings. If the Contractor does not comply with the above requirements, the Railroad will post a flagger or flaggers, as it deems necessary, for the duration of the Project. The Contractor shall not be entitled to any additional compensation if this occurs.

The Railroad may utilize independent consultant services to inspect and verify that any and all Work on Railroad ROW is being undertaken in accordance with Railroad safety requirements. Failure to comply with RR safety requirements may result in a stop Work order.

6.3.2.3 Cost for Flagging, Inspection, Design Plan Reviews

The Contractor shall be responsible for and include in its Contract Price the amount that will be required for Railroad flagging and Inspection, Railroad maintenance of temporary crossings, Railroad agreement, permit and coordination fees, Railroad design plan review costs, and other Railroad-related costs. The Contractor shall keep a log of actual time that the Railroad personnel are flagging. Copies of the log shall be submitted to CDOT. The Railroad will bill the Contractor for Railroad flagging and Inspection, and other Railroad costs incurred on the Project. The estimated cost for one (1) flagger is $1300.00 for an eight (8) hour basic day with time and one-half or double time for overtime, rest days and Holidays. Work days longer than

8-hour days, and double shifts will require the utilization of additional Railroad flaggers.

The rates of pay of the Railroad employees customarily called upon to act for the protection of the Railroad are the Railroad rates in effect at the time of the Work for the various classes of labor. Compensation, property damage and public liability insurance, vacation and Holiday time, Railroad retirement and unemployment taxes, health and welfare, and supervision charges shall be added to the above rates. The Railroad will, upon request, furnish prospective bidders with an estimate of cost of the flagging protection that will be required; but such estimate shall be understood to be approximate only, and no guarantee is made that the total cost of such flagging will not be in excess of the estimated amount.

6.3.2.4 Authority of Railroad Flaggers and Inspectors

The Railroad flaggers and inspectors shall have the right to direct the Contractor to stop Work on, over, under, or adjacent to Railroad property, if the Railroad in its sole discretion determines that the Work being performed is hazardous to Railroad property and/or operations. The Railroad will give immediate notice to CDOT of any Work stoppage. The Contractor, working with CDOT, shall be responsible for resolving to the Railroad's satisfaction the problems resulting in the Work stoppage. The Contractor shall accommodate any and all requests made by the Railroad that serve the purpose of avoiding hazards to Railroad property and/or operations. Neither the Railroad nor CDOT will have any liability to the Contractor for costs or delays associated with such Work stoppage or requirements associated with avoidance or hazardous situations.

6.3.3 Utility Crossings

The Railroad is not responsible for Utilities on Railroad ROW. The Contractor shall locate all Utilities on Railroad ROW within the immediate vicinity of the Work. The Contractor shall certify to the Railroad that all the Utilities on Railroad ROW and within the immediate vicinity of the Work have been identified and properly located.

6.3.4 Design Reviews

CDOT has obtained Consent-to-Maintain approval from UPRR and BNSF based on the Basic Configuration that does not modify Railroad facilities. If the Work proposed by the Contractor does not include modification of the Railroad facilities, Design Review by the Railroad will not be required for permanent Work.

6.3.4.1 Design Reviews for Work Modifying Railroad Facilities

Design Reviews by the Railroad will only be required if the Contractor proposes to modify the Railroad facilities. Railroad review is separate and independent from CDOT oversight. The Contractor shall coordinate the required Railroad design reviews with the Railroad. The Contractor shall enter into a preliminary engineering agreement with UPRR for all plan reviews. The Contractor shall be responsible for all costs associated with the preliminary engineering agreement with UPRR. All plans submitted to the Railroad for review and approval shall be in English units. All documents shall be delivered to the contacts identified in section 6.2.2. The

Contractor shall allow for 30 day review and comment periods by the Railroad for all plan reviews and submittals as identified in Section 3.5 of the *Guidelines for Railroad Grade Separation Projects*. The Contractor at a minimum is required to submit 30% and 100% level plans to the Railroad in order to obtain design approval from the Railroad.

The Contractor shall obtain Railroad Approval in writing of design plans for all of the design elements of the Work on the Railroad's property.

6.3.5 Construction Requirements

The Contractor shall comply with the rules and regulations of the Railroad or the instructions of its representatives in relation to the proper manner of protecting the tracks and property of the Railroad and the traffic moving on such tracks, as well as the wires, signals, and other property of the Railroad, its tenants, or licensees, at and in the vicinity of the Work during the period of construction.

Construction submittals specified in UPRR/BNSF Joint Guidelines for Railroad Grade Separation Projects shall be coordinated by the Contractor.

All construction Work within the Railroad ROW and/or properties shall be performed during daylight hours unless authorized otherwise by the Railroad.

The Contractor shall coordinate with the Railroad prior to beginning any construction on or adjacent to the Railroad ROW. The Contractor shall schedule and hold a Railroad preconstruction conference. Working windows for demolition and construction shall be coordinated with the Railroad and Railroad flaggers.

The Contractor shall provide written notification to the Railroad at least 30 Days in advance of the date on which the Contractor expects to begin Work on Railroad properties. All notices and correspondence with the Railroad shall contain the Project number and location. Copies of such agreements, notices, and correspondence shall also be submitted to CDOT.

The Contractor shall obtain Railroad agreement in writing, in advance, on methods and procedures covering all Work on the Railroad's property. Upon completion of the Work, the Contractor shall remove from the premises of the Railroad ROW all Equipment, surplus Material, and debris, leaving such premises in a neat condition satisfactory to the Railroad.

If the Contractor employed upon the Railroad's property performs the Work thereon contrary to the Railroad-approved plans, specifications, and requirements of the Contract Documents, or if the Contractor performs the Work on the Railroad's property in a manner deemed hazardous by the Railroad (to its property and facilities or the safe and expeditious movement of its traffic), the Railroad will have the right to stop the Work on the Railroad's property until the acts or omissions of the Contractor have been fully rectified to the satisfaction of the Railroad.

The Contractor shall be responsible to the Railroad and its tenants for all damages for delays that may be sustained by the Railroad, its tenants, their employees, or freight in their care caused by any interference that could have been avoided by proper handling of the Project Work.

All of the limitations and obligations imposed upon the Contractor by this Section shall apply with equal force and effect to any Subcontractor performing any Project Work for the Contractor upon the Railroad's ROW. The Contractor shall be primarily liable and responsible to the Railroad for all acts or omissions of any Subcontractor employed upon the Railroad's ROW.

Nothing herein contained shall be construed to preclude the Railroad from proceeding against the Contractor and Subcontractors individually or collectively.

The Contractor shall perform its Work in such manner and at such times as shall not to endanger or interfere with the safe operation of the tracks and property of the Railroad and the traffic moving on such tracks, as well as wires, signals, and other property of the Railroad, its tenants or licensees, at or in the vicinity of the Work. The Contractor shall not pile or store any Materials, tools, or park any Equipment, when not in use, closer to the center of nearest railroad track than permitted by the following clearances:

1. 25 feet, 0 inches horizontally from nearest track centerline to edge of obstruction
2. 23 feet, 4 inches vertically above top of rail

Falsework, forms, bracing or other construction supports, driven piles, etc., shall be no closer to the center of the nearest railroad track than permitted by the following temporary construction clearances:

1. 12 feet, 0 inches horizontally from nearest rail
2. 21 feet, 6 inches vertically above top of rail

An orange temporary fence shall be installed to identify temporary easements and flagging areas.

Any proposed variance of the above clearances shall be submitted by the Contractor to the Railroad, the Public Utilities Commission if applicable, and to CDOT; and the variance shall not be undertaken until approved by the Railroad and until CDOT has obtained any necessary authorization from any governmental body or bodies having jurisdiction. No extra compensation will be allowed in the event the Contractor's Work is delayed pending Railroad approval and Governmental Approval.

If required, temporary crossings at grade of the Railroad's tracks or roadways or unloading pits on the Railroad's ROW will only be constructed by the Railroad. If required, the Contractor shall execute a temporary crossing agreement with the Railroad. The Contractor shall only enter Railroad property through routes approved by the Railroad. The Contractor shall maintain any such crossings so established in good condition at all times; shall keep flange-ways free of ice, snow, dirt, rock and debris; and shall install, operate, maintain and remove in a manner satisfactory to the Railroad suitable barricades adequate to prevent unauthorized vehicles or Equipment from using such crossings or roadways. All costs and expenses for installation, maintenance, and operation of any such crossings or roadways and barricades, whether the Work performed by the Railroad or by the Contractor, shall be included in the Work, notwithstanding anything elsewhere contained herein. The Contractor shall not at any time

cross the Railroad's tracks with vehicles or Equipment of any kind or character, except at existing public crossings or at crossings established, as provided for in this paragraph.

The Contractor shall provide positive drainage along the Railroad at all times during and at the end of construction in the area.

Work shall be performed in accordance with plans and specifications approved by the Railroad and in such manner and at such times as shall not endanger or interfere with the safe operation of the tracks and other facilities. The requirements of the Railroad and the instructions of its representatives shall be complied with relating to the proper manner of protecting the tracks, pipelines, wire lines, signals, and all other property at said location; the traffic moving on such tracks; and the removal of tools, Equipment, and Materials.

The Contractor shall not pursue any levies, Liens, or encumbrances of any nature whatsoever against Railroad property, and shall promptly remove any Lien against Railroad property arising from performance of Work hereunder by the Contractor or any Subcontractor; and if not removed within 20 Days, the Railroad may act to remove same and all the costs shall be paid by the Contractor.

Railroad representatives, conductors, flagmen, or watchmen will be provided by the Railroad to protect its facilities, property, and movements of its trains or engines when, in the opinion of the Railroad's representative, they are necessary because of the Contractor's operations while working on or adjacent to Railroad property or its tracks.

The cost of all personnel deemed necessary by the Railroad and provided by the Railroad for the protection of the Railroad facilities and trains during the period of constructing the Project, and the cost of installing protective devices in the case of impaired clearance, as above specified, shall be borne by the Contractor.

At the request of the Railroad, the Contractor shall remove from the Railroad premises any employee of said Contractor or any Subcontractor who fails to conform to the instructions of the Railroad's representative. All Work on the Railroad premises shall be suspended until such request of the Railroad is met. The Contractor shall indemnify the Railroad against any claim arising from the removal of any such employee from the Railroad premises.

Upon completion of the Work to be performed on Railroad property, the Contractor shall promptly remove from Railroad property all tools, Equipment, and Materials placed thereon by the Contractor or the Contractors agents. The Contractor shall restore said property to the same state and condition as when the Contractor entered thereon and shall leave said property in a clean and presentable condition satisfactory to the Railroad.

The Contractor shall provide written notice to the Railroad that the Work has been completed within 10 Days following completion and Acceptance of such Work. All notices and correspondence with the Railroad shall contain the Project number and location. Copies of such agreements, notices, and correspondence shall also be submitted to CDOT.

6.4 RTD Requirements

6.4.1 RTD Safety Requirements

The Contractor shall complete On-Track safety training per RTD access permit requirements. The Contractor shall attend RTD weekly meetings on Wednesday for the duration of the Work that affects safety and operations of RTD facilities.

6.4.2 RTD Access Permit

The Contractor shall request and obtain a "RTD Light Rail Right of Way Access Request/Permit from RTD prior to commencing any Work to be done on Structure F-17-IE over a space 25 feet left or right of the tracks. All work shall be scheduled with RTD Maintenance of Way and RTD Construction Management. Contractor shall not disturb portions of Project site beyond areas in which the Work is indicated. Contractor shall provide protection to limit non-construction personnel from entering the work zone.

The permit form can be found at www.rtd-denver.com/documents/rail-operations-**access-permit**.doc. The Contractor shall submit the completed ROW Access Permit request form to railopspermits@rtd-denver.com

6.4.3 Notification of Beginning Work

The Contractor shall provide a minimum of 60 days written notice to RTD prior to beginning any work on Structure F-17-IE that requires Access Permit approval by RTD.

6.4.4 Flagging

The Contractor shall schedule RTD Flaggers for any Work required in the Approved Access Permit, and for all work within 25 feet of centerline of tracks. The Contractor shall provide a minimum of 5 days notice to RTD, or less only if approved by RTD. All costs associated with Flagging shall be borne by the Contractor.

6.4.5 Allowed Closures

The Contractor will be allowed thirty (30) full nighttime closures of the RTD light rail services for required bridge work on structure F-17-IE. Each closure shall be a maximum of ten (10) hours in duration. Specific days and hours for the closures shall be coordinated by the Contractor with CDOT and RTD for Approval at least 21 days in advance of each planned closure. The Contractor shall provide a Methods and Means Statement for the work identifying protection and/or adjustment of RTD facilities provided during the Work.

6.4.6 Design Review

RTD will Review and Approve any Work on Structure F-17-IE, and any other work that has potential to affect safety and operations of RTD LRT facilities. RTD's Light Rail Design Criteria, latest addition, shall apply.

6.5 Deliverables

At a minimum, the Contractor shall submit the following for review, Approval, and/or Acceptance:

Deliverable	Review, Acceptance, or Approval	Schedule
Notify Railroad of Project commencement	Railroad	Within 5 Days of NTP1
Preliminary engineering review agreement	Execution by UPRR	Prior to submittal of design reviews to UPRR
Contractor Right of Entry Agreement	Execution by Railroad	Prior to commencing any Work on Railroad ROW
Written notice of intent to commence work on Railroad ROW	Railroad	30 days prior to beginning Work or per the executed agreement with the Railroad, whichever is greater.
Written notice of intent to stop work on Railroad ROW	Railroad	15 days prior to completing all Work or per the executed agreement with the Railroad, whichever is greater.
Design plans for Work within Railroad ROW	Approval by Railroad	Per Railroad review requirements. Approval prior to beginning any Work on Railroad property.
Construction Submittals for Work within Railroad ROW	Approval by Railroad	Per Railroad requirements.
Design plans for Work within the limits identified in the RTD Access Permit.	Approval by RTD	Prior to beginning any Work identified in the RTD Access Permit.
Notify RTD to commence Work	Acceptance by CDOT	60 days prior to beginning Work identified in RTD Access Permit
RTD Access Permit	Approval by RTD	As per Permit Requirements

7.0 UTILITY RELOCATIONS

This Section addresses the Utility Company (or Utility Owner) requirements. It does not apply to existing stormwater facilities, irrigation ditches, Intelligent Transportation Systems, Variable Message Signs, video and video detection systems, traffic signals, railroads, or street lighting, all of which shall be installed, removed, relocated and/or protected in place by the Contractor and/or the Utility Owners pursuant to other sections of the Contract Documents.

7.0.1 Definitions

Capitalized terms used, but not defined herein, shall have the meanings given to them in Book 1 Section 1.1. In addition, the following capitalized terms shall have the meanings set out below:

Betterments has the meaning given to it in the Utility Relocation Agreements.

Contractor's Utility Tracking Report has the meaning given to it in Section 7.3.2.

Pothole Log means the existing utility pothole information included with the Reference Documents.

Public Utilities means a Utility that is owned by a public agency or political subdivision of the State.

Private Utilities means a Utility that is owned by a private company.

Requested Relocation means any Private Utility relocation requested by a Utility Owner to be performed by the Contractor.

Unidentified Utility means a Utility that is discovered during construction that was not included in the Utility Data.

Utility Data means the Pothole Log, the Utility Drawings, the Utility Matrix, and utility information from the Utility Owners that are included with the Reference Documents.

Utility Drawings means the Utility plan design sheets included with the Reference Documents.

Utility Matrix means the Project Utility Matrix that lists the Utility Data included with the Reference Documents.

Utility Permit has the meaning given to it in the Utility Relocation Agreements. Additionally, CDOT will issue permits for Utility Work on C-470, and local agency permits will be required for Utility Work on City and County Streets.

Utility Relocation Agreements (URA) means the executed agreements between CDOT and Utility Owners for the Project that are included with the Reference Documents.

Utility Work means any portion of the Work relating to (a) the Relocation of any Utility, (b) any Betterment, or (c) any Requested Relocation, in each case (a), (b) and (c), as further described in this Section 7.

7.1 General Utility Work Obligations

The Project will affect both existing and planned Utilities. The Contractor shall coordinate and cooperate with CDOT and the Utility Owners to ensure that all Utility Work (whether performed or furnished by the Utility Owners or by Contractor) is performed in accordance with the executed URAs. The physical limits of the Contractor's obligation for the performance of Utility Work shall extend as far as is necessary to permit construction of the Project (taking into account the requirements of the Utility Owners, Governmental Persons with jurisdiction, and adjacent property owners), whether inside or outside the Right-of-Way (ROW).

The Contractor shall use reasonable efforts to anticipate and avoid Utilities, and to otherwise minimize and/or mitigate the consequences of the Utility Relocations.

7.1.1 Utility Work

The Contractor shall carry out all Utility Work in accordance with the requirements of the Utility Relocation Agreements (URA), Book 1 Section 6.2 Utility Relocations, and this Section 7.

Utility Work includes, but is not limited to, the following:

1. Verification of all Utilities, as identified or described in the Utility Data, and the identification of all other Utilities, including in each case all necessary potholing located within the Project limits or otherwise impacted by the Work.
2. Development and updates of the Contractor's Utility Tracking Report.
3. Preparation and execution of the Utility No-Conflict Close-Out Form for Acceptance by CDOT.
4. Negotiation, preparation, and execution of the Utility Work Order for each Utility Relocation, including preparing and providing such written information concerning the Project (such as reports, plans and surveys), as requested by CDOT and the Utility Owner.
5. Preparation of Utility Relocation design for each Public Utilities Relocation, and obtaining the design acceptance by the Form of Design of Relocation Acceptance Letter (DRAL) from the Utility Owner and Acceptance by CDOT.
6. Construction of the Public Utilities Relocations, including service lines and temporary relocations, and obtaining the construction acceptance by the Form of Construction of Relocation Acceptance Letter (CRAL) from the Utility Owner and Acceptance by CDOT.
7. Removal of Abandoned existing Public Utilities. If impractical to remove, flow-fill of abandoned existing Public Utilities that are greater than 12-inches in diameter.
8. Review of the Utility Relocation design for each Private Utilities Relocation, then verification of and acceptance by the Form of DRAL that each Utility Relocation is compatible with the Project.
9. Reimbursement to Private Utility Owners for design if incurred by such Utility Owners in performing Utility Work.
10. Cost for all Utility Work associated with Public Utility Owners as part of their Contract Price.
11. Inspection of the Utility Relocation construction for each Private Utilities Relocation, then verification and acceptance by the form of CRAL that each Utility Relocation is compatible with the Project.

12. Reimbursement to Private Utility Owners for construction costs incurred by such Utility Owners in performing Utility Work within an easement owned by the Private Utility Owner.
13. Reimbursement to Utility Owners for, or acquisition of, replacement easement required for Utility Work pursuant to Book 2, Section 8, Right-of-Way.
14. Resurfacing and restriping of streets and parking areas and reconstruction of curb and gutter and sidewalks, where necessary, due to Utility Work performed by Contractor or performed by a Utility Owner within the Project limits.
15. Providing public information for Utility Work performed by Contractor, or performed by the Utility Owner.
16. Performing traffic control for Utility Work performed by Contractor, or performed by the Utility Owner.
17. Providing survey coordinates in the field for design and construction of the Utility Work performed by the Contractor or performed by the Utility Owner.
18. Performing Incidental Utility Work as defined in URA.
19. Performing and coordinating As-Built plans for all Utility Work Orders.
20. Identification and removal of abandoned Private Utilities as required to complete the Work.
21. For utilities relocated or adjusted and cross the facility, encasement is required to extend to CDOT ROW line, unless otherwise Approved, in the Work Order, by CDOT.
22. For existing utilities that are not impacted and have encasement, the encasement is required to be extended to grading catch points beyond any roadside ditches. Casing material should match existing.
23. For existing utilities that are not impacted and do not have encasements, the Contractor is not required to install casing.
24. All necessary Work associated with Utility Work.

7.1.2 Exclusions from Utility Work

Utility Work excludes, but is not limited to, the following:

1. Issuance of any Utility Permit to any Utility Owner.
2. Provision and maintenance of any insurance in excess of the Contractor's obligations in Book 1, Section 9.
3. Any work expressly required to be undertaken by CDOT or a Utility Owner in accordance with URA or the terms of any Work Order.
4. Construction of the Private Utilities Relocations, including service lines and temporary relocations, unless identified as a Requested Relocation.
5. Abandonment of existing Private Utilities, unless identified as a Requested Relocation.
6. Utility Removal Work outside of the Project limits.
7. Providing traffic control when Utility Work is outside of the Project limits.

7.1.3 Contractor’s Responsibility to Perform

The Contractor shall perform all activities included in the Utility Work with respect to each impacted Utility regardless of the following:

1. Whether or not the Utility was indicated in the Reference Documents or, if indicated, whether or not the Utility was accurately indicated.

2. The type of action, if any (e.g., Relocation, Protection-in-Place), feasibility, estimated duration of Work time, or any other characteristic of any Relocation concept(s) proposed for the Utility in the Reference Documents.

The allocation of responsibility for any Utility Work to a Utility Owner pursuant to this Section 7 or to a URA shall not relieve the Contractor of the obligation to coordinate with the Utility Owner as necessary for such Utility Work to be timely performed, or of the obligation to perform any other Utility Work not specifically assigned to such Utility Owner. The circumstances under which the Contractor will be entitled to a Change Order for Utility Work are set forth in the Contract Documents.

7.2 Performance Standards

7.2.1 Utility Owners

Except as otherwise provided in the applicable URA, all Utility Relocation designs and construction of relocations furnished or performed by the Contractor shall be consistent with the Utility Owner's written specifications, standards of practice (which may include design format), and construction methods that are current at the Proposal Due Date. The Contractor shall obtain all such written specifications, standards of practice, and construction methods from the Utility Owners. In the event of a conflict between the requirements of the Utility Owner and the requirements of the Contract Documents, CDOT in its sole discretion will determine which shall govern. The Contractor shall be responsible for resolution of any unresolved ambiguity prior to proceeding with any Utility Work.

Replacements for any existing Utilities shall be designed and constructed to provide service at least equal to that offered by the existing Utility, unless the Utility Owner approves a lesser replacement.

In performing the Utility Work, the Contractor shall ensure that all Utility Work results in Utilities being located in a manner to allow future Utility maintenance to be performed by the relevant Utility Owners without disruption to the operation or maintenance within the completed Project limits

7.3 Identification of Utilities

7.3.1 CDOT-Supplied Information

See Reference Documents for a list of all known Utility Owners within and/or adjacent to the ROW, including contact information.

CDOT has completed an initial Utility investigation, including some subsurface utility engineering, and has identified the Utilities that may be impacted by the Project. CDOT has not performed a complete investigation of service lines. The results of CDOT's investigations are shown on the Utility Information Sheets (UIS's) in the Reference Documents and the manhole and pothole logs in the Reference Documents. The results of CDOT's investigations are indicated in the Utility Data that is included with the Reference Documents.

7.3.2 Contractor's Investigations

Without limiting its ability to negotiate a Change Order with respect to any Unidentified Utility, the Contractor shall take all actions reasonably practicable to identify and confirm the existence, exact location, size, and type of all Utilities within the Project limits or otherwise potentially impacted by the Project, whether or not such Utilities are shown in the Utility Data, including all potentially impacted service lines. Such actions shall include making diligent inquiry at the offices of the Utility Owners, consulting public records, and conducting field studies (such as subsurface utility engineering), as appropriate, taking into consideration the possibility that Utility Owners may provide inaccurate or inexact information with regard to their Utilities. If the Contractor's investigations identify Unidentified Utilities, the Contractor shall notify CDOT and the relevant Utility Owner immediately upon discovery. Thereafter, CDOT, the Contractor, and the relevant Utility Owner shall execute a Utility No Conflict Close-Out Form, or pursuant to a Utility Work Order treat an Unidentified Utility as either a Contractor-Relocated Utility or an Owner-Relocated Utility.

The Contractor shall at least monthly and otherwise upon CDOT's reasonable request, deliver to CDOT for review in accordance with the Utility Owner's URA, the Contractor's Utility Tracking Report which shall update and expand the Utility Matrix to include the following information (unless otherwise agreed between the Parties):

1. Meeting dates with Utility Owners for each draft Utility Work Order
2. The relevant number and execution date of each executed Utility Work Order
3. Each No Conflict Close-Out Form execution date
4. Each DRAL execution date
5. Each CRAL execution date
6. Completed As-Built plans delivery date, to or by the Contractor, as applicable
7. Identification of all changes made since the prior Contractor's Utility Tracking Report

7.3.3 Utility Work Orders

The Contractor, Utility Owner, and CDOT, in that order, shall execute a Utility Work Order prior to commencement of any Utility Work. The Contractor may prepare a single Utility Work Order covering more than one Relocation, Betterment, or Requested Relocation with the consent of CDOT and the relevant Utility Owner.

Prior to executing any Utility Work Order, the Contractor and CDOT shall meet with the relevant Utility Owner to negotiate the relevant draft Work Order, including the following:

1. In accordance with the procedures set out in the applicable URA, the scope of work, the implementation schedule, and any exhibits
2. In accordance with the paragraphs below, cost and payment responsibility

The costs for work performed by the Contractor under a Utility Work Order for Betterments or Requested Relocations shall be negotiated between the Contractor and the Utility Owner. If the Utility Owner will be reimbursing the Contractor for any costs in connection with Utility Work, the Contractor shall provide a definitive cost estimate to the Utility Owner in accordance with the Utility Owner's standard practice and with the requirements of the applicable URAs, and shall submit such estimate to CDOT. After Acceptance by the Utility Owner and CDOT, the estimate

shall be incorporated into the applicable Work Order. If a Utility Owner is responsible for the payment of any amount of the cost of a Betterment or Requested Relocation pursuant to a Work Order, payment must be made to the Contractor in accordance with the terms of the applicable URA. CDOT shall not be responsible for the payment of any amount with respect to a Betterment or Requested Relocation other than as expressly provided for in the URAs or as otherwise agreed to by CDOT upon CDOT's execution of the relevant Work Order.

The costs for construction of Utility Relocations within a Utility Owner permanent easement, or any Utility Relocation design work performed by a Private Utilities Owner under a Utility Work Order for each Private Utilities Owner Relocated Utility, shall be negotiated between the Contractor and the Utility Owner. If the Contractor will be reimbursing a Utility Owner for any eligible costs in connection with Utility Work, the Contractor shall obtain a definitive cost estimate from the Utility Owner in accordance with the Utility Owner's standard practice and with the requirements of the applicable URAs, and shall submit such estimate to CDOT. After Acceptance by the Contractor and CDOT, the estimate shall be incorporated into the applicable Work Order. If the Contractor is responsible for the payment of any amount of the cost of a Private Utilities Owner Relocated Utility pursuant to a Utility Work Order, that amount shall be paid to the Utility Owner in accordance with the terms of the applicable URA.

For Betterments and Requested Relocations, the draft Utility Work Order shall include the direct impact of such Utility Work Order on the performance of the Work and the Contractor's ability to follow the Initial Schedule (or, as the case may be, revised Initial Schedule), in each case taking into account the Contractor's obligations under Book 1, Section 13.3.1.2, and such other information as CDOT may reasonably require.

On the basis of the meetings held in accordance with the second paragraph under Section 7.3.3, the Contractor shall submit each draft Utility Work Order to CDOT for Acceptance.

CDOT shall provide comments or Acceptance within 14 Days of delivery of the draft Utility Work Order by the Contractor to CDOT, provided that the Contractor shall not execute or otherwise commit to enter into any Utility Work Order or perform any work in respect of any Utility Work without CDOT's prior written Approval of the Final or Revised Utility Work Order.

If CDOT accepts the draft Utility Work Order and Accepts both the cost, and the impact of such Utility Work Order on the performance of the Work, if any, then:

1. The Contractor shall submit the Accepted Utility Work Order to the Utility Owner and CDOT for Approval/execution and shall itself execute the Utility Work Order, in each case in accordance with the applicable URA; and
2. The Contractor shall thereafter perform the Utility Work for which it is responsible pursuant to such Utility Work Order as part of the Work.

The Contractor shall revise any Utility Work Order if and when necessary in accordance with the terms of the applicable URA. Such a revised Utility Work Order shall be drafted and executed in accordance with the same procedures applicable to the drafting and execution of the original Utility Work Order under this Section 7.

7.3.4 Damage to Utilities Caused by the Contractor

The Contractor shall be responsible for any damage caused by the Contractor or its Subcontractors, employees, or agents to property, Utilities, structures, or Subcontractors, employees, or agents of the Utility Owners. The Contractor shall immediately notify the affected Utility Owner of any utility damaged by the Contractor during performance of the Work.

Promptly after the Contractor's discovery of such damage, or the Contractor's receipt of notice of any such damage from the Utility Owner or from any other source: (a) the Contractor shall repair the damage to the Utility Owner's satisfaction; or (b) at the Utility Owner's election, the Utility Owner may make such repairs at the Contractor's expense. The Contractor shall make payment to a Utility Owner within 60 Days of receipt of the Owner's invoice.

7.3.5 Multiple Moves

The Contractor shall be responsible for all costs incurred by CDOT, the Contractor, or the Utility Owner to subsequently relocate any Utility already Relocated to accommodate the Project.

7.4 Utility Coordination

7.4.1 General

The Contractor shall be responsible for all coordination with the affected Utility Owners to accomplish each Utility Relocation in accordance with the applicable URAs. In the discharge of its coordination responsibilities, the Contractor shall:

1. Keep Utility Owners fully informed of schedules with regard to Utility Work. The Contractor shall provide to the Utility Owners, as soon as practicable, an estimated schedule for their respective Utility Work and shall notify the Utility Owners of any significant changes to the schedule as soon as practicable.
2. Keep Utility Owners fully informed of changes that affect their Utilities.
3. Consider, to the extent practicable, Utility Owners' needs for the allocation of resources to perform their respective Utility Work in a timely manner.
4. Keep Utility Owners involved in making decisions that affect their Utilities so Utility Owners are able to provide uninterrupted service to their customers, or to be subject to the least interruption practicable as approved by the Utility Owner.
5. Avoid multiple Relocations of the same Private Utility, in accordance with the Contract Documents.

7.4.2 Utility Meetings

7.4.2.1 Between the Contractor and Utility Owners

In addition to any meetings or negotiations required under Section 7.3.3, above, and Book 1, Section 6.2, after execution of a Utility Work Order, the Contractor shall schedule regular meetings with the relevant Utility Owner to complete the Utility Work pursuant to the terms of the Utility Work Order. The Contractor shall not unreasonably deny any request by a Utility Owner to meet regarding any Utility Work. The Contractor shall provide CDOT with at least 5 Days prior notice of any meeting with a Utility Owner, which CDOT may attend in its discretion, unless a shorter notice period is agreed to by CDOT and is reasonably necessary under the

circumstances.

7.4.2.2 Between CDOT and the Contractor

The Contractor and CDOT shall meet as necessary and otherwise as reasonably requested by the other party to discuss and resolve matters relating to the Utility Work.

The party proposing a meeting shall provide the other party with a minimum of 5 Days prior notice of any proposed meetings, unless a shorter notice period is agreed to and reasonably necessary under the circumstances.

7.4.2.3 Meeting Minutes/Correspondence

The Contractor shall produce meeting minutes of all Utility Work meetings with Utility Owners and/or CDOT and shall distribute copies of the meeting minutes to CDOT for Acceptance and, when such meetings were attended by a Utility Owner, to the relevant Utility Owner, not later than 7 Days after each meeting date. The Contractor shall provide copies of all correspondence between the Contractor and any Utility Owner to CDOT for Acceptance no later than 7 Days after delivery.

7.4.3 Review Schedules

In developing the Project schedule, the Contractor shall allow appropriate time periods for the performance of all tasks shown on each Utility Work Order.

All schedules and deadlines for the design and construction of Utility Work set forth in the Utility Work Orders shall prevail over any estimated times noted in the Utility Matrix.

7.4.4 Notices

7.4.4.1 To Utility Owners

To maintain the Project schedules, the Contractor shall issue all notices in writing to the Utility Owners called for under the URA, with copies submitted for review to CDOT.

Notice shall be given to respective Utility Owners when the Contractor is performing Work adjacent to their Utilities. The Contractor shall be solely responsible for and liable for any damage to any Utilities that are damaged due to the Work.

7.4.4.2 To CDOT

The Contractor shall be responsible for verifying progress of Utility Work performed by the Utility Owner and for notifying CDOT should the Contractor have cause to believe that the Utility Owner will not meet the specified timeframe(s) in the Utility Work Order. The Contractor shall provide such written notice to CDOT for review immediately after discovery.

If the Utility Owner is performing Utility Work that requires a CDOT Utility Permit, the Contractor shall verify that the CDOT Utility Permit has been obtained and is being complied with. If the Contractor determines that the Utility Owner does not have the required CDOT Utility Permit, or is in violation of the terms and conditions of such permit, the Contractor shall provide such written notice to CDOT for review immediately after discovery.

7.4.4.3 To Utility Notification Center of Colorado (UNCC)

The Contractor shall arrange for the UNCC to provide software and training for the Contractor to order call tickets to have utility field locates performed. The Contractor shall contact UNCC to make arrangements for the training. This will allow the Contractor to order its own call tickets via e-mail.

7.5 Failure of Utility Owner to Cooperate or Timely Perform

The Contractor shall use reasonable efforts to obtain the cooperation of each Utility Owner as necessary for carrying out the Utility Work. The Contractor shall provide written notice to CDOT immediately for review if:

1. The Contractor becomes aware that any Utility Owner is not cooperating in identifying Utilities, negotiating or executing Utility Work Orders, performing or approving any Utility Work, or delivering DRALs , CRALs and Exhibits F(1 or 2);
2. A Utility Owner fails to complete design and/or construction work for which it is responsible on or before the deadline established in the applicable Utility Work Order; or
3. Based on the progress made by the relevant Utility Owner, the Contractor believes that there is a possibility that the Utility Owner will not complete the Relocation of an Owner-Relocated Utility or any other Utility Work as required pursuant to a Utility Work Order to the extent and in the manner shown on the Utility Drawings within the time limits set out in the applicable Utility Work Order; and
4. In each case (1), (2), or (3) advising CDOT whether the Utility Owner has complied in all respects with the requirements of this Section 7, including compliance with the applicable URA and the applicable Utility Work Order with respect to the relevant portion of the Utility Work.

After delivery of such notice, the Contractor shall continue to diligently pursue the Utility Owner's cooperation and shall assist CDOT in any attempts to reach a solution through the dispute resolution procedure outlined in the applicable URA. The Contractor shall document any incurred costs as a direct result of the Utility Owner's failure to cooperate or perform its obligations under the applicable URA in a timely manner.

In the event that CDOT pursues legal action against a Utility Owner pursuant to Section 43-1-1411, Colorado Revised Statutes, the Contractor shall cooperate as reasonably requested by CDOT in connection with such legal actions, including having the Contractor's staff and Subconsultants act as witnesses in such legal actions and providing information, reports, graphs, photos, plans, renderings, and similar materials to CDOT's counsel at the Contractor's expense.

7.6 Utility Work Procedure

7.6.1 Utility Agreements

The Reference Documents include the CDOT URAs with each Utility Owner whose Utilities are, or may be, affected by the Project.

If the Contractor identifies Utility Work that is required from a Utility Owner without an agreement, CDOT may enter into an agreement with such Utility Owner. The Contractor shall

not be a party to any agreement and shall not be responsible for negotiating such agreement. CDOT will be responsible for drafting and negotiating the agreement. The Contractor shall be responsible to coordinate with such Utility Owner as if it had an executed URA.

7.6.2 As-Built Plans

Where the Utility Owner performs the Utility Work, the Utility Owner will provide As-Built plans of the relocation to CDOT and to the Contractor as soon as practicable, but not later than 90 Days after execution of a CRAL (URA) . The As-Built plans may be in the form of redlining changes that deviate from the Accepted DRAL plans or labeling the Accepted DRAL plans “constructed per plan.” The Contractor shall show the Utility As-Built information on the final Project As-Built Documents for Acceptance.

Where the Contractor performs the Utility Work, the Contractor shall provide As-Built plans of the relocation to CDOT and the Utility Owner as soon as practicable, but not later than 90 Days after execution of a CRAL (URA). The As-Built plans may be in the form of redlining changes that deviate from the Accepted DRAL plans or labeling the Accepted DRAL plans “constructed per plan.” The Contractor shall show the Utility As-Built information on the final Project As-Built Documents for Acceptance.

7.6.3 UTILITY SPECIFICATIONS

The Contractor shall consult with Utility Owners for required specifications and as listed in the executed URAs

7.7 Exhibits

URA

Exhibit A - Utility No-Conflict Closeout Form

Exhibit B - Form of Utility Work Order

Exhibit C - Form of Design of Relocation Acceptance Letter (DRAL)

Exhibit D - Form of Construction of Relocation Acceptance Letter (CRAL)

Exhibit E – Form of Buy America Certification

7.8 Deliverables

At a minimum, the Contractor shall submit the following for review, Approval, or Acceptance:

Deliverable	Review, Acceptance, or Approval	Schedule
Contractor's Utility Tracking Report	Review	Monthly or at CDOT's request per Section 7.3.2
Utility No-Conflict Closeout	Acceptance	As required per Section 7.1.1
Draft Utility Work Order	Acceptance	As required per Section 7.3.3
Final or Revised Utility Work Order (including costs)	Approval	As required per Section 7.3.3
Design of Relocation Acceptance Letter (DRAL)	Acceptance	As required per Section 7.1.1
Construction of Relocation Acceptance Letter (CRAL)	Acceptance	As required per Section 7.1.1
As-Built plans	Acceptance	As required per Section 7.6.2
Meeting minutes	Acceptance	As required per Section 7.4.2.3
Correspondence between Contractor and any Utility Owner	Acceptance	As required per Section 7.4.2.3
Written notices to Utility Owners	Review	As required per Section 7.4.4.1
Written notice to CDOT of Utility Owner not meeting Work Order time frame	Review	As required per Section 7.4.4.2
Written notice of Utility Permit violation	Review	As required per Section 7.4.4.2
Written notice of failure of Utility Owner to carry out the Utility Work	Review	As required per Section 7.5

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

8.0 Right-of-Way

CDOT will acquire Right-of-Way (ROW) for this Project, as defined in the ROW plans in Book 4. It has been determined that this Project will be constructed within existing CDOT ROW and the additional ROW being acquired, as defined in the ROW plans in Book 4. In the event that the Contractor requests additional ROW acquisition to perform the Work and the CDOT Region 1 ROW Manager Approves such request, all Contractor Acquisitions, shall be performed by the Contractor in compliance with the requirements of this Section 8 and Book 1. The Contractor shall be responsible for completion of all steps in the ROW acquisition process for Contractor Acquisitions, except as specified herein and for condemnations (if needed). The Colorado Attorney General's Office will file and prosecute all condemnations needed for Contractor Acquisitions. The Colorado Attorney General's Office will file and prosecute all condemnations needed for Contractor Acquisitions.

If the Contractors design requires the acquisition of ROW, the Contractor is required to:

1. Include the cost of all ROW acquisitions in the Price Proposal
2. Assume sole responsibility of all costs associated with the acquisition of any such ROW, including the cost of obtaining any necessary environmental approvals or mitigation, costs associated with surveying and ROW plan preparation, relocation costs and the costs of improvement demolition.
3. Acquire properties for the Project on behalf of CDOT with title reflecting: DEPARTMENT OF TRANSPORTATION, STATE OF COLORADO, whose legal address is 4201 E. ARKANSAS AVENUE, DENVER, COLORADO 80222.

If the Contractors proposed design requires the acquisition of ROW, the Contractor is not entitled to:

1. Any Change Order for time or money as a result of site conditions (e.g., hazardous materials, differing site conditions, geotechnical issues, utilities, etc.) on the ROW.
2. Any Change Order for time or money as a result of any delay, inability, or cost associated with such ROW.

8.1 Administrative Requirements

CDOT will retain possession of each parcel and all improvements, if any, made thereon by the Contractor. The Contractor's access and use of the ROW arises solely from the permission granted by the CDOT Region 1 ROW Manager under the Contract.

8.1.1 Acquisition and Relocation Standards

All ROW acquisition and relocations for Contractor Acquisitions shall be performed in accordance with all applicable federal and state laws, including:

1. The federal Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended, including regulations promulgated pursuant to such Act, which appear at 49 CFR Part 24, as amended.

2. Right of Way Requirements for Design/Build Projects, 23 CFR 710.313.

3. The Colorado Relocation Assistance and Land Acquisition Policies Act, Section 24-56-101, et seq., C.R.S., as amended.

4. The Colorado Eminent Domain Act, Section 38-1-101, et seq., C.R.S., as amended.

5. CDOT's Right of Way Manual, as amended.

6. CDOT's authority to acquire property and to acquire through eminent domain, if necessary, is set forth in Section 43-1-208, 210 and 43-3-106, C.R.S., as amended.

7. If the acquisition of additional ROW by the Contractor is Approved by the CDOT Region 1 ROW Manager (Contractor Acquisitions), all appraisal, acquisition negotiation, and relocation shall be done by CDOT-Approved consultants, subject to CDOT's Approval of the Contractor's support documentation for such appraisal, acquisition, and relocation activities. The appraisal review function and the establishment of Fair Market Value (FMV) is the responsibility of CDOT.

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8. All Contractor Acquisitions will be acquired in CDOT's name.

8.1.2 Status of Right-of-Way

CDOT will acquire permanent and temporary ROW, including, Fee parcels, Permanent Easements (PE's) and Temporary Easements (TE's) for the Project as shown on the DRAFT ROW Plans included in Book 4. The DRAFT ROW Plans included in Book 4 – Contract Drawings shows the ROW that CDOT owns and will acquire for the Project. Any additional ROW is to be determined by the Contractor's design and Approved by CDOT's Region 1 ROW Manager.

It is expected that acquisition of all right-of-way will be completed such that the Contractor has access to all parcels shown on the DRAFT ROW Plans by NTP2. Any parcels not expected to be acquired by NTP2 will be identified in Appendix A of this Section 8. The Contractor shall be allowed access to each parcel identified in Appendix A of this Section 8 as each parcel is acquired. CDOT will provide the Contractor with status reports, written notice of parcel access, and any applicable restrictions that may apply. The Contractor shall not access any parcel on which access has not been provided.

The Contractor shall not trespass on private property. If CDOT discovers a trespass, the Contractor shall promptly vacate possession of the private property upon receipt of notice of the trespass from CDOT. If any liability occurs as a result of the trespass, the Contractor shall be responsible for such liability, including indemnifying CDOT for such liability. In the event that trespass occurs, and especially in instances where trespasses persist after receipt of a notice to desist from CDOT, the Contractor shall be liable for liquidated damages as defined in Book 1, Section 17.

8.1.3 Right-of-Way Manager and Compliance with CDOT Right-of-Way Manual

The Contractor shall retain a ROW Manager if additional ROW acquisition (Contractor Acquisitions) is Approved by CDOT's Region 1 ROW Manager. The Contractor's ROW Manager

shall be responsible for all ROW coordination and compliance requirements. The Contractor's ROW Manager shall be certified for both acquisition and relocation services pursuant to the CDOT ROW Manual and Approved by CDOT's Region 1 ROW Manager. The Contractor's ROW Manager shall coordinate all acquisition and relocation activities with CDOT's Region 1 ROW Manager (or a delagee). The Contractor shall comply with all of the requirements of the CDOT ROW Manual.

8.1.4 Property Management Plan

CDOT's property acquisition includes the acquisitions as shown in the ROW plans included in Book 4. As set forth in Section 8.3, the Contractor shall be responsible for demolition of any improvements acquired by the Contractor. Demolition cannot begin until CDOT's Region 1 ROW Manager has given the Contractor written authorization to access or take possession of the property and must be completed prior to commencing construction activities on the property. If such demolition is not immediately completed, the Contractor shall be responsible for all property management requirements for such improvements until their demolition. The Contractor shall establish and maintain a written Property Management Plan for the Work, including such improvements, which shall establish administrative and technical means for the security, hazardous materials assessment, demolition, debris removal, site clearing, and cleanup of building structures and property improvements acquired as a part of the ROW on the Project. The Property Management Plan shall conform to Chapter 7, Property Management, of the CDOT Right of Way Manual and shall specifically address the following components:

1. Project Land and Improvements
2. Demolition
3. Rodent Control
4. Safety
5. Hazardous Waste and Storage Tanks
6. Hazardous Materials
7. Improvement Security and Maintenance

The Property Management Plan shall be submitted to CDOT for Approval prior to Contractor being allowed access to the property.

8.1.5 Permission to Enter Property

The Contractor shall secure permission to enter property forms prior to entering any property outside the ROW for surveying, nonintrusive environmental investigation, and appraisal purposes. It shall be the Contractor's sole responsibility to obtain the forms, and the Contractor shall be responsible for any and all damages and claims. The Contractor shall submit copies of all permission to enter property forms to CDOT prior to entering the property.

8.2 Acquisition and Relocation Requirements

8.2.1 Request for Right-of-Way

Should the Contractor determine that additional ROW parcels, including Fee, Permanent Easement (PE), Utility Easement (UE) or Temporary Easement (TE) parcels are necessary or desirable for the Work, the Contractor shall submit a written request to CDOT's Region 1 ROW Manager for Approval. If acquisition of both TEs and/or permanent ROW, including Fee, PEs and UEs, are requested, the application, Approval and acquisition requirements of this Section are applicable. Each request shall include the following documentation:

1. Identification of the additional parcels and an explanation of a justification for its need. An illustration of each parcel superimposed on an aerial photograph with approximate area of the parcel will be sufficient.
2. A preliminary cost estimate for each parcel that includes separate values for land, improvements, damages or benefits (if any), relocation (if applicable), and survey, ROW Plan preparation, appraisal, and acquisition costs.
3. A title commitment report for each parcel, including all supporting documentation, not more than 30 Days old.
4. Any maps, deeds, or other information available to the Contractor that shall expedite the acquisition.
5. Acquisition stage relocation plan in accordance with the CDOT Right of Way Manual, Chapter 5, if additional ROW acquisition requires occupant or personal property relocation.

CDOT's Region 1 ROW Manager will review each request and, if Approved, shall notify the Contractor in writing (Contractor Acquisitions). CDOT will notify the Contractor of any deficiencies and may request a resubmittal of the request. The Contractor shall promptly correct any deficiencies and resubmit the appropriate documentation.

8.2.2 Acquisition of Right Of Way

If authorization is obtained from CDOT, the Contractor may begin the ROW acquisition process for the Contractor Acquisitions. All aspects of the ROW process for the Contractor Acquisitions must be conducted in compliance with CDOT's Right of Way Manual, including ROW plans preparation and Approval (approval/authorized by CDOT), appraisal and valuation review and approval (draft appraisal review and Fair Market Value preparation is the responsibility of CDOT), and conduct and procedures for acquisition negotiations and relocation, if needed. For any fee parcels acquired, the Contractor shall obtain and provide appropriate release documents for any encumbrances affecting the acquisition parcels, including but not limited to releases of deeds of trust, mortgages, easements, and liens. If liens or encumbrances affect permanent easement parcels, CDOT should be notified of such liens and encumbrances and the Contractor will be required to take the action requested by CDOT, which may include subordination or release of the liens and encumbrances. An appropriate environmental clearance, as specified in Book 2, Section 5 - Environmental Requirements, shall be required as a prerequisite for Approval /authorization of ROW plans for the additional ROW.

If the additional ROW is to be acquired from a landowner with whom CDOT has an unsettled condemnation case, the same appraiser that prepared the appraisal for CDOT's condemnation case shall value the additional ROW. CDOT's Region 1 ROW Manager must Approve the value determination for the additional ROW, or if required, issue a fair market value determination prior to any offer being made to the landowner. CDOT's Region 1 ROW Manager must review and Approve all administrative settlements, which are settlements over the amount of the CDOT-Approved offer to purchase at FMV that are made to the landowner.

If authorization is obtained from CDOT's Region 1 ROW Manager for the Contractor to purchase Contractor Acquisitions, the Contractor's ROW Manager shall meet with the CDOT Region 1 ROW Manager, or a delagee, every two weeks to review the status of the ROW acquisitions and relocations, if applicable, and check Quality Control/Quality Assurance as needed, until the completion and CDOT Approval of the acquisitions and relocations. The

Contractor is responsible for creation and implementation of an internal status tracking and quality control system for all ROW processes.

The steps of the CDOT right of way acquisition process, the entity that is responsible for completion of each step (Contractor or CDOT), and approximate time frames for some of the steps are set forth in Appendix C of this Section 8. Note that all time frames in this table are approximate suggestions as opposed to binding agreements and cannot be relied upon by the Contractor.

8.2.2 Utility Easements

Construction of the Project will affect existing Utilities. Known easements for existing Utilities and Utilities to be relocated are shown in the ROW Plans included in Book 4. If the Contractor determines that it needs Utility Easements (UE), the Contractor, at its sole cost and expense, shall be responsible for acquiring such Additional UE's.
The acquisition of Additional UEs requires prior Approval by CDOT. Acquisition of Additional UEs must be conducted in compliance with Book 2, Section 8.2.1, above.

8.2.4 Relocation

If the additional Contractor Acquisitions requires occupant or personal property relocation, such relocation shall be conducted in compliance with Chapter 5 of the CDOT Right of Way Manual. The steps of the CDOT Relocation process, the entity that is responsible for completion of each step (Contractor or CDOT), and approximate time frames for some of the steps are set forth in Appendix C of this Section 8. Note that all time frames in this table are approximate suggestions as opposed to binding agreements. The Contractor shall be fully responsible for the relocation schedule. As a general proposition, appropriate completion of the CDOT ROW relocation process takes longer than one would reasonably think it might. If an acquisition displaces an occupant, working through the relocation process will likely be the longest most Schedule-specific required ROW activity. As a result, prioritizing such acquisition is recommended.

8.2.5 Condemnation

If the Contractor cannot reach an agreement with a landowner for the acquisition of the Contractor Acquisitions, the Contractor may request in writing that CDOT acquire the additional ROW through condemnation proceedings. The Contractor shall prepare and submit to CDOT for Approval a properly completed Condemnation Memorandum and Check List Form in accordance with the instruction contained in the CDOT Right of Way Manual. The condemnation request shall include a certified check payable to the Clerk of the District Court of the appropriate county in the amount of the required condemnation filing fee and approved fair market value or value finding.

The Contractor must work with CDOT's Region 1 ROW Manager to establish a realistic schedule for filing condemnations, and setting and holding immediate possession hearings. It usually takes at least four months from the date of submission of a condemnation request file to the Colorado Attorney General's Office for a condemnation action to be filed and an immediate possession hearing to be set and held. The Contractor shall not enter any properties until notified in writing that legal possession has been obtained. If a settlement is negotiated with a property owner after the filing of a condemnation, the Contractor will be consulted on the settlement; however, CDOT shall have authority to decide whether to accept or reject the

settlement. If a settlement is agreed to, the Contractor must pay the full amount of the settlement. If a valuation trial is held, the Contractor shall be responsible for payment of the full amount of the valuation trial award, including, if any, all interest, costs and attorneys' fees per CRS 38-1-122.

If there are any time delays as a result of condemnation proceedings, all costs associated with such time delays shall be borne by the Contractor. The Contractor may be required to provide personnel for pre-trial and court testimony for each condemnation request.

8.2.6 Contractor Possession of Acquired Properties

After each parcel of Contractor Acquisitions is acquired, the Contractor shall submit a complete parcel acquisition file, which shall include but not be not limited to, copies of offer letters, fair market value determinations or value findings, fully executed easement documents and/or agreements, the negotiator's signed diary, a statement signed by the property owner acknowledging receipt of payment in full, and if relocation is applicable, all required relocation forms. Parcel acquisition files shall be submitted to CDOT's Region 1 ROW Manager for Approval no later than 2 Working Days following payment to the landowner. The Contractor shall not access or take possession of any requested ROW parcel for construction until CDOT provides written authorization.

8.3 Construction Requirements

8.3.1 Demolition

CDOT is in the process of demolishing all buildings, structures, and other improvements on the ROW acquired. The Contractor shall demolish all buildings, structures, and other improvements on any additional acquisitions. In the event that ROW acquisition, that has been Approved by CDOT' ROW Manager, includes acquisition of structures or improvements, demolition of such structures and improvements shall be completed in compliance with this Section. The Contractor shall conduct and document asbestos and hazardous waste, including lead-based paint inspections and any required action in accordance with Book 1 of the Contract Documents. All Utilities associated with such buildings, structures, and other improvements installed on or connected to the ROW shall be abandoned or removed in accordance with the requirements of the applicable Utility Owner as part of the demolition, unless otherwise noted.

The Contractor shall properly remove and dispose of all regulated asbestos containing material, all Universal and other types of hazardous waste, and any other regulated material other than solid waste prior to demolition of any property in accordance with all federal, state, and local regulations. The Contractor shall obtain all permits or other approval documents required by state and local government, including a demolition plan Approved by the CDOT Manager of Property Management at Headquarters in accordance with the Occupational Health and Safety Administration (OSHA) demolition regulations 1926.850 prior to demolition of any property. Such documentation shall be submitted to CDOT's Region 1 ROW Manager for Acceptance at least 15 Days prior to demolition.

All Utilities associated with such buildings, structures, and other improvements installed on or connected to the ROW shall be abandoned or removed in accordance with the requirements of the applicable Utility Owner as part of the demolition, unless otherwise noted.

8.3.2 Restoration of Property and Landscape

Temporary easements are temporary rental of property. At the end of the rental period, property occupied by the Contractor under a temporary easement shall be returned to the landowner in the same condition it was in prior to taking possession. The Contractor shall, at its sole cost and expense, repair and/or replace or restore any damage to TE property that may occur as a result of the Contractor's occupancy, to a condition reasonably equal to that existing prior to the damage. Restoration may include, but is not limited to, repair, replacing in kind, rebuilding, or replanting. Such restoration must be completed prior to the termination date of the TE rental term.

8.3.3 Protection of Property

Once the CDOT Region 1 ROW Manager provides written authorization to access property, in accordance with the requirements herein, the Contractor shall manage and minimize losses to the property in accordance with the requirements of Book 2, Section 18 - Maintenance during Construction. This shall include the installation of temporary chain-link security fencing sufficient to contain animals, people, etc. The temporary fencing shall be installed prior to removing any ROW fencing or sound barrier in place within the Project limits.

8.3.4 Prohibition Against Coercion, Impairment of Safety, and Inconvenience of Displaced Occupants Still in Occupancy

In compliance with 23 CFR §710.313(d)(3), CDOT may establish hold off zones around occupied properties whose occupants are being displaced by a ROW acquisition, but have not vacated the premises. If such zones are established, no construction-related activity will be allowed within the hold off zone until CDOT's Region 1 ROW Manager provides written authorization in accordance with section 8.2.

In compliance with 23 CFR §710.313(d)(4), adequate access shall be provided to occupied properties whose occupants are being displaced by a ROW acquisition, but have not vacated the premises, to ensure emergency and personal vehicle access.

In compliance with 23 CFR §710.313(d)(5), utility service must be available to all to occupied properties whose occupants are being displaced by a ROW acquisition, but have not vacated the premises, at all times prior to and until relocation is completed.

In compliance with 23 CFR §710.313(d)(6), open burning should not occur within 305 meters (1,000 feet) of occupied properties whose occupants are being displaced by a ROW acquisition, but have not vacated the premises.

8.4 Deliverables

At a minimum, the Contractor shall submit the following to CDOT for review, Approval, and/or Acceptance (if applicable):

Deliverable	review, Acceptance or Approval	Schedule

Property Management Plan (required if Contractor obtains ROW)	Approval	Prior to being allowed access to the property.
Parcel Acquisition Files (required if Contractor obtains ROW)	Approval	No later than 5 Working Days following tender of payment to land owner
Condemnation memorandum and check list form (required if Contractor obtains ROW)	Approval	Concurrent with the request to CDOT for property condemnation
Request for additional ROW (letter)	Approval	As needed
Permission to enter property form	Approval	Prior to entering private property
Asbestos and lead based paint inspection (required if Contractor performs demolition)	Approval	15 Days prior to demolition
Appraisals (required if Contractor obtains ROW)	review/Approval	Prior to finalization
Value Findings/FMV (required if Contractor obtains ROW)	Approval	Prior to offer being made
Relocation Plan (required if Contractor obtained ROW requires relocations)	Approval	With request for additional ROW
Administrative settlement (if required for Contractor obtained ROW)	Approval/review	Prior to execution of MOA

All deliverables shall also conform to the requirements of Section 3 - Quality Management.

8.5 Appendices

Appendix A Right of Way Schedule – Intentionally left blank

Appendix B Right of Way Improvement Demolition Schedule – Intentionally left blank

Appendix C Steps of the CDOT Right of Way Acquisition Process, Entity Responsible for Completion of Each Step, and Approximate Time Frames

Appendix D Steps of the CDOT Relocation Process, Entity Responsible for Completion of Each Step, and Approximate Time Frames

APPENDIX A

Right-of-Way Schedule

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APPENDIX B

Schedule of Improvements to be Demolished

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APPENDIX C
STEPS OF THE CDOT RIGHT OF WAY ACQUISITION PROCESS, ENTITY RESPONSIBLE FOR COMPLETION OF EACH STEP, AND APPROXIMATE TIME FRAMES

Description of ROW Task	Entity Responsible for Completion of ROW Task	Approximate Time Frame for Completion of ROW Task	Entity Responsible for Review and Approval of ROW Task	Approximate Time Frame for Completion of Review and Approval of ROW Task	Comments
Survey	Contractor	Variable depending on scope 2-4 weeks for smaller surveys, 2-4 months for larger surveys	CDOT Region 1 Survey Unit	2-3 weeks from submission	This is only survey of property boundary and topography needed for development of ROW Plans

Description of ROW Task	Entity Responsible for Completion of ROW Task	Approximate Time Frame for Completion of ROW Task	Entity Responsible for Review and Approval of ROW Task	Approximate Time Frame for Completion of Review and Approval of ROW Task	Comments
Delivery of Engineering Design of Improvements Requiring ROW Completed to a Sufficient Level to Ensure that Location, Size and Shape of ROW Parcels Will Not Change as Design is Advanced	Contractor	Variable depending on scope of improvements to be designed	CDOT Design Review Team and CDOT Region 1 ROW Manager	Variable depending on scope of improvements designed	Completion of sufficient design to this level is a common cause of delay in the ROW plans development process

Description of ROW Task	Entity Responsible for Completion of ROW Task	Approximate Time Frame for Completion of ROW Task	Entity Responsible for Review and Approval of ROW Task	Approximate Time Frame for Completion of Review and Approval of ROW Task	Comments
Appraisal and Appraisal Review	Appraisal: Contractor Appraisal Review: CDOT	6-8 weeks per appraisal per landowner 1-2 weeks to review an appraisal	CDOT Region 1 ROW Manager	1-2 weeks to review an appraisal	If the estimated value of the acquisition is $5,000 or less, a value finding can be prepared by a real estate specialist and an appraisal/appraisal review is not needed. All requests for valuation by a value finding vs. an appraisal must be Approved by CDOT.
Acquisition Negotiation	Contractor	4-6 weeks for the initial negotiation. 2 weeks for a final offer letter. 2 weeks for a last and final offer letter, if given.	CDOT must review and Approve all administrative settlements.	2-4 Days to review and Approve backup documentation of completed acquisition negotiations	Contractor cannot use duress or coercion in acquisition negotiations

Description of ROW Task	Entity Responsible for Completion of ROW Task	Approximate Time Frame for Completion of ROW Task	Entity Responsible for Review and Approval of ROW Task	Approximate Time Frame for Completion of Review and Approval of ROW Task	Comments
Condemnation	Colorado Attorney General's Office	At least four months to file a condemnation petition, serve it on the parties, set and hold an immediate possession hearing. Valuation trials can take a year or more from the date of filing the condemnation petition.	Initial condemnation request to be approved by CDOT Region 1 ROW Manager with final approval by CDOT's HQ ROW unit	1-3 weeks for initial request to be approved and sent to Attorney General's office Condemnation time varies depending on court system.	All offers to purchase must be made in CDOT's name, so the Attorney General's Office is properly authorized to represent the CDOT as the condemning authority in the condemnation proceeding.
Certification that Acquisition was completed in compliance with State and Federal Requirements	Contractor		CDOT Region 1 ROW Manager		

APPENDIX D
STEPS OF THE CDOT RELOCATION PROCESS, ENTITY RESPONSIBLE FOR COMPLETION OF EACH STEP, AND APPROXIMATE TIME FRAMES

Description of ROW Task	Entity Responsible for Completion of ROW Task	Approximate Time Frame for Completion of ROW Task	Entity Responsible for Review and Approval of ROW Task	Approximate Time Frame for Completion of Review and Approval of ROW Task	Comments
Relocation Planning Studies Required by 49 CFR §24.205	Contractor	Variable depending on scope 1-2 weeks for smaller studies	CDOT HQ ROW Unit	1-2 weeks from submission	
Relocation Advisory Services Required by 49 CFR §24.205	Contractor	Variable. Typically continuous throughout relocation process.	CDOT Region 1 Acquisition/Relocation Supervisor. Note: Approval of a specific deliverable is not required. Rather this is general oversight.	Generally continuous throughout relocation process.	CDOT Region 1 Acquisition/Relocation personnel can assist with advisory services, as needed.

Description of ROW Task	Entity Responsible for Completion of ROW Task	Approximate Time Frame for Completion of ROW Task	Entity Responsible for Review and Approval of ROW Task	Approximate Time Frame for Completion of Review and Approval of ROW Task	Comments
Provide Displaced Occupants Notice that They Have 90 Days to Vacate the Premises, and Later That They Have 30 Days to Vacate the Premises 49 CFR §24.203	Contractor	The 90-Day notice is provided at the time the written offer to purchase the property is provided to the landowner	CDOT Region 1 Acquisition/Relocation Supervisor. Note: Approval of a specific deliverable is not required. Rather this is general oversight.		90 Days for a displaced occupant to find a replacement property and move into it is the minimum required by law. As a practical matter, that is too short, especially for displaced businesses. It is desirable to lengthen this minimum time frame as much as possible. At least 6 months is a better expectation. The 30-Day notice cannot be provided until possession of the underlining property is obtained.

Description of ROW Task	Entity Responsible for Completion of ROW Task	Approximate Time Frame for Completion of ROW Task	Entity Responsible for Review and Approval of ROW Task	Approximate Time Frame for Completion of Review and Approval of ROW Task	Comments
Business /Farm/Non-Profit Relocation Prepare and Submit Requests for Reimbursement of all Available Business Relocation Monetary Benefits, Including Expenses Incurred Searching for a Replacement Property, 49 CFR §24.301, Moving Expenses, 49 CFR §24.301, Reestablishment, 49 CFR §24.304, or single "In Lieu" payment, 49 CFR §24.305	Contractor	Variable Note: since these are reimbursable expenses, the displaced occupant must actually incur the expenses before a request for reimbursement can be prepared.	CDOT HQ ROW Unit	2-5 Days per submittal	

Description of ROW Task	Entity Responsible for Completion of ROW Task	Approximate Time Frame for Completion of ROW Task	Entity Responsible for Review and Approval of ROW Task	Approximate Time Frame for Completion of Review and Approval of ROW Task	Comments
Residential Relocation Prepare and Submit Requests for Reimbursement of all Available Residential Relocation Monetary Benefits, Including Replacement Housing Payment, 49 CFR §24.401 and Moving Expenses, 49 CFR §24.301	Contractor	Variable Note: since these are reimbursable expenses, the displaced occupant must actually incur the expenses before a request for reimbursement can be prepared.	CDOT HQ ROW Unit	5-10 Days per submittal	

9.0 SURVEY

9.1 Administrative Requirements

9.1.1 Standards

The Contractor shall meet all applicable federal, state, and local requirements related to surveys, records, and monuments.

9.1.2 Project Survey Coordinator

The Contractor shall designate a Colorado Professional Land Surveyor as the Project Survey Coordinator. The Project Survey Coordinator shall be in responsible charge of all Contractor survey Activities on the Project. The Project Survey Coordinator shall direct and review all survey Work and shall be the point of contact for all survey related Activities. Contractor survey staff shall perform Work under the direct supervision of the Project Survey Coordinator.

9.1.3 CDOT-Supplied Survey Data

The full extent of control point information to be supplied by CDOT is provided in Book 4.

The full extent of survey and mapping information to be supplied by CDOT is provided in Book 4. Three levels of surveys are provided to the Contractor:

1. Aerial mapping was flown and developed to produce 1 foot contours accurate to one half of one contour interval.
2. Supplemental TMOSS survey was performed and merged with the aerial mapping to meet CDOT Class C and D-TMOSS survey minimal horizontal and vertical requirements as per Chapter 5 of the CDOT Survey Manual.
3. LiDAR mapping of existing bridges was performed for horizontal and vertical clearance at those locations.

Surveys were performed according to the guidelines for preliminary surveys published in the CDOT *Survey Manual*. The Contractor is responsible to verify all survey information, including but not limited to tie-in's to all existing features. If the Contractor identifies any inaccuracies in CDOT provided survey information it shall be the Contractor's responsibility to provide additional surveys as necessary to resolve the inaccuracies as necessary to complete the Work

9.1.4 Contractor-Supplied Survey Data

Except as provided by CDOT above, the Contractor shall provide all other surveys required for completion of the Work.

9.1.5 Preservation of Survey Monuments

The preservation of all private and public survey markers and monuments is mandatory. The marker position shall be accurately preserved prior to disturbing any such marker. Stakes and Monuments which are damaged or destroyed by the progress of construction shall be replaced by the Contractor at no additional cost to the Department.

9.1.6 CDOT Monuments

If any CDOT survey monuments are at risk of being destroyed at any time within the Right-of-Way (ROW), the Contractor shall immediately notify CDOT. The Contractor shall reset such monumentation as part of the Work and provide CDOT with the appropriate records after resetting. The Contractor shall also reset markers for properties acquired after NTP1 and provide any associated records to CDOT accordingly.

9.1.7 Other Agency Monuments

The Contractor shall coordinate with all other agencies with monuments on the Project to protect and restore their monuments as required to complete the Work. The Contractor shall notify the agency affected as soon as it becomes known that a marker is in a position that will interfere with new construction or with Contractor operations.The Contractor may assume that the agency affected will send a new marker disk, which has been properly stamped, together with instructions for establishment of the new marker, or CDOT will provide a marker disk. The Contractor shall set the new marker in accordance with the provided instructions and the requirements of the Contract. The new marker shall be set under the direct supervision and responsible charge of the Project Survey Coordinator or other Colorado Professional Land Surveyor. Where required by Colorado statute, the new marker shall bear the registration number of the responsible Professional Land Surveyor.

9.1.8 Survey Records

The Contractor shall prepare and maintain supporting documentation, including but not limited to, field notes, drawings, and calculations for all survey Work on the Project. All survey records shall conform to the formats shown in the CDOT *Survey Manual*.

Fieldbooks shall contain daily records of points set and or measurements observed. The information recorded shall contain: date, crew members' names, point no., description, staking information, and sketches. If the survey information is collected electronically, information recorded shall be provided to the Project Engineer in a hard copy format that is intuitive, clear and related to the supplemental information recorded in the field books. All linear surveys, such as slope stakes and blue tops, shall have the station and offset information related to the measured information. Non-linear surveys such as structures staking shall have sketches relating electronic information, such as point numbers, to the sketch.

Such records shall be neat, legible, accurate, and maintained by the Contractor in a neat and orderly manner. The Contractor’s Project Survey Coordinator shall be required to sign and seal all survey documentation in accordance with State law. All such documentation shall be transmitted to CDOT at the completion of the Work.

9.2 Design Requirements

9.2.1 Design Control Surveys

The Contractor shall plan, schedule, and perform all surveys and monumentation necessary to maintain and supplement the Project control network for the design Work on the Project.

The Contractor shall submit to CDOT a revised Project Control Diagram showing all modifications to the Project control network.

9.2.2 Design Surveys

The Contractor shall arrange for all supplemental survey information and Utility locations necessary to complete the design. Surveying shall be performed in accordance with the CDOT *Survey Manual*. The Contractor shall deliver the data (in InRoads TMOSS survey format) to CDOT for review. Traffic control and permits necessary to complete the survey shall be the responsibility of the Contractor.

9.3 Construction Requirements

9.3.1 Construction Control Surveys

The Contractor shall plan, schedule, and perform all surveys and monumentation necessary to maintain and supplement the Project control network for the construction layout of the Work.

9.3.2 Construction Layout Surveys

The Contractor shall plan, schedule and perform all staking and construction layout required for the Work. Unless indicated otherwise on the Survey Tabulation Sheet, all survey work and staking intervals shall be done in accordance with the latest edition of the CDOT Survey Manual.

9.3.3 As-Built Surveys

The Contractor shall plan, schedule, and perform all surveys required to document the location of As-Built features on the Project for the payment of items as requested by CDOT.

The Contractor shall deliver the data (in InRoads TMOSS survey format) and field notes to CDOT for review upon completion of the survey. Errors and omissions found by CDOT shall be corrected by the Contractor and resubmitted. All work in completing the As-Built survey shall be at the responsibility of the Contractor and shall be completed in accordance with the CDOT *Survey Manual*.

9.3.4 ROW Monumentation

The Contractor shall replace all ROW monumentation and private survey lost or destroyed during the progression of the Work.

The Contractor shall submit to CDOT for Acceptance a revised ROW monumentation sheet listing all ROW monumentation reset by the Contractor. The ROW monument sheets shall be included in the project ROW plans. The sheet shall be stamped and signed by the Project Survey Coordinator.

9.4 Deliverables

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

Deliverable	Review, Acceptance. or Approval	Schedule
Any discrepancies in control point information provided that is reported to CDOT	Review	Within 60 Days of NTP1
Documentation for the preservation or re-monumentation of any survey monument	Approval by the affected agency	Submit with As-Built Documents
Revised ROW Monumentation Sheet	Acceptance	Prior to Final Acceptance
Documentation/date of the location of As-Built features on the Project (in InRoads TMOSS survey format) and field notes	Acceptance	Prior to Final Acceptance
Field Books	Acceptance	Prior to Final Acceptance

10.0 GEOTECHNICAL AND ROADWAY PAVEMENTS

10.1 Design Requirements

10.1.1 Geotechnical Investigations

Geotechnical investigations performed by CDOT are provided in Book 3, Section 10.

The Contractor shall be responsible for any supplemental subsurface investigation necessary to complete the Work. Geotechnical investigations shall comply with the requirements of the 2016 CDOT Field Materials Manual, the 2016 CDOT M-E Pavement Design Manual, and any other applicable standards necessary to perform the Work. The roadway pavement sampling shall conform to the recommendations in the Region Soil Sampling Checklist presented in Chapter 200 of the 2016 CDOT Field Materials Manual. All supplemental investigations made by the Contractor shall be documented in geotechnical investigation reports of similar format as those referenced geotechnical documents and submitted to CDOT for review and comment prior to Acceptance within 30 days following completion of the fieldwork. All supplemental investigations made by the Contractor for non-CDOT roadways shall be documented in separate Geotechnical Investigation Reports according to the maintaining entity and submitted to CDOT for Acceptance. No additional compensation will be provided for any additional costs for subsurface exploration work within areas of contaminated soil or groundwater. Required modifications to the pavement design and Life Cycle Cost Analysis performed by CDOT as a result of conditions identified by the supplemental subsurface investigations performed by the Contractor shall be addressed in accordance with the Contract Documents. Required modifications to approved pavement design Alternate Technical Concepts as a result of conditions identified by the supplemental subsurface investigations performed by the Contractor shall be the sole responsibility of the Contractor.

10.2 Construction Requirements

10.2.1 Pavement Structure

The Pavement Structure is defined as the combination of one or more of the following courses placed on a subgrade to support and distribute the traffic load to the roadbed:

- Subbase. The layer or layers of specified or selected material placed on a subgrade to support a base course, surface course, or both.
- Base Course. The layer or layers of specified or selected material placed on a subbase or a subgrade to support a surface course.
- Surface Course. One or more layers of a pavement structure designed to accommodate the traffic load. The top layer of the Surface Course resists skidding, traffic abrasion, and the disintegrating effects of climate.

To provide for adequate sulfate resistance, all concrete supplied to the project shall be designed for Class 2, Severity of Sulfate Exposure. The Contractor may, at their expense, have a certified laboratory test the subgrade as per the 2016 CDOT Field Materials Manual. Testing shall be at the same schedule and frequency as required for preliminary soil survey. The Contractor may

propose a different Class of Exposure for the Project based on the test results. Concrete for foundation elements shall be designed for Class 2, Severity of Sulfate Exposure.

10.2.2 Roadway Pavement Analysis and Design

CDOT has performed the pavement design and Life Cycle Cost Analysis to determine the pavement type, minimum thickness, and minimum sub-grade stabilization requirements that shall be used on this project.

The Contractor shall be responsible for the final pavement design using Version 2.2 of the AASHTO Ware Pavement ME Design program (ME Design) for all pavement constructed as part of this project. Contractor designs shall utilize Colorado-specific calibration model and shall follow the inputs, coefficients, material properties, etc. set forth in the pavement design report. The material properties of the pavement, base, and subgrade used during construction shall follow those used in the ME Design. The Contractor shall explicitly delineate any differences between the two.

The Functional Classification of mainline C-470 shall be Interstate for pavement design.

Rigid pavement designs consist of Portland Cement Concrete Pavement (PCCP), containing load transfer devices and tied shoulders and shall be designed for a 30-year design life.

Flexible pavement designs consist of two inches of Stone Matrix Asphalt (Fibers) (Asphalt) with Hot Mix Asphalt (Grading S) (100) (PG 64-22) utilized for all lower lifts of the pavement in order to match the existing adjacent asphalt thickness. Asphalt pavement shall only be used for tie-ins to existing flexible pavement, and for bridge decks as defined in Section 15.

The pavement shall be ***uniform*** for all of the segments identified. For pavement construction uniform shall be defined as:

1. Pavement material thickness and subgrade treatment shall be consistent for the linear section limits defined in Table 10.2.2.
2. Consistent subgrade drainage shall be provided laterally.

All pavement shall be constructed full width, including inside and outside shoulders. Location descriptions, Pavement Type (Rigid) and Pavement Thickness for Project Roadways are shown in Table 10.2.2 – Pavement Design Parameters.

Table 10.2.2 – Pavement Design Parameters

C-470 Area	Pavement Type	Design Life (years)	2018 Daily Truck Volume	PCCP over Lime Treatment (inches)	PCCP Overlay (over existing pavement) (inches)
Wadsworth to Platte Canyon Sta. 770+00 to 865+00	Rigid	30	2,742	9.5	10.0
Platte Canyon to Santa Fe Station 865+00 to 940+00	Rigid	30	2,742	9.5	10.0
Santa Fe to Lucent Sta. 940+00 to 1005+00	Rigid	30	2,871	9.5	10.0
8.5Lucent to Broadway Sta. 1005+00 to 1068+00	Rigid	30	2,702	9.5	10.0
Broadway to University Sta. 1068+00 to 1147+00	Rigid	30	3,198	9.5	10.5
University to Colorado Sta. 1147+00 to 1195+00	Rigid	30	3,079	9.5	10.0
Colorado to Quebec Sta. 1195+00 to 1310+00	Rigid	30	3,079	9.5	10.0
Quebec to Yosemite Sta. 1310+00 to 1384+00	Rigid	30	3,596	9.5	11.0
Yosemite to I-25 Sta. 1384+00 to 1415+00	Rigid	30	3,157	9.5	10.0

Notes: All PCCP design contain 1.5 inch dowels and No. 6 tie bars

All PCCP shall be doweled and tied per CDOT M-412 unless otherwise specified by CDOT. Dowel size may change from the M-412 standard based on the results of subsequent ME Design analyses. The Contractor shall prepare a pavement jointing plan per CDOT M-412, the 2016 CDOT M-E Pavement Design Manual, and industry best practices. The jointing plan shall be submitted to CDOT for Review and Acceptance.

The Contractor shall be responsible for designing, providing and maintaining detour pavements in a safe and serviceable condition, subject to CDOT Acceptance. Asphalt detour pavements shall utilize at a minimum conformity to Hot Mix Asphalt (Grading S) (100) (PG 64-22). Concrete detour pavements shall utilize concrete conforming to the requirements of Class P or Class E concrete. The Contractor shall determine the type and thickness of detour pavement and submit a Detour Pavement Design to CDOT for Acceptance in accordance with the 2016 CDOT Pavement Design Manual. The detour thickness design shall be based on the actual subgrade strength and traffic loading for the length of time the detour is anticipated to be in service. The minimum required detour pavement thickness is 8 inches for Portland Cement Concrete and 10 inches for Hot Mix Asphalt. Alternatives to these minimum thicknesses may be proposed to CDOT for consideration through the Alternative Technical Concepts process. If the Contractor's Detour Pavement Design requires thicknesses greater than the minimum to serve for the life of the detour pavement, these shall be provided at no additional cost. The design thickness of all detour pavements shall be Accepted by CDOT prior to any placement. The Contractor shall be responsible for maintenance of all detour pavements.

10.2.3 Trail Pavement Mix Designs, Types, Thickness Requirements and Sections

The Contractor shall present mix designs for concrete 30 days prior to concrete placement to CDOT for Approval.

The Contractor shall construct the trail concrete pavement to the thickness requirements for the Project, as set forth in the Table 10.2.3 below:

Table 10.2.3 – Trail Pavement Design Parameters

Location	Required Trail Pavement Section Thickness (inches)		
	Concrete	Aggregate Base Course (Class 6)	Embankment
All project Trails	6”	4”	24 inches Subgrade moisture/recompaction minimum See Section 11 & Section 13

10.2.3 Existing Pavement Sections

Where existing C-470 is to be overlaid with PCCP, and the old edge of pavement does not align with a longitudinal joint in the new pavement, an extra set of tie bars will be placed in the new pavement across the transition between the old pavement and widened section of lime treated base. This transition location will not become a sawed joint.

10.2.4 Alternate Pavement Designs

Intentionally left blank.

10.2.5 Non-CDOT Roadways Pavement Designs

Intentionally left blank.

10.2.6 Structure Foundation Analysis and Design

Intentionally left blank.

10.3 Construction Requirements

The Contractor shall construct the PCCP, SMA, HMA, and all other paved surfaces in accordance with the requirements of the Contract Documents. Construction of Contractor-designed permanent paved surfaces shall not commence until the pavement design has been Accepted by CDOT.

Where it is required to cut existing pavement, the cutting shall be done to a neat work line full depth with a pavement-cutting saw or other method as Approved by the CDOT.

At no time should the blunt end of guardrail, barrier, end treatment, etc. be exposed to oncoming traffic.

The Contractor shall be responsible for constructing Safety Edge as specified in Book 2, Section 13.

Any curb and gutter or other roadside feature, which is to remain and is damaged as a result of the contractor's operation, shall be replaced at the contractor's expense.

10.3.1 Roadway Pavement Construction Requirements

A minimum of thirty days prior to the proposed construction of any pavement on the Project, a Pre-paving Conference shall be conducted. At the Pre-paving Conference, the Contractor shall present to CDOT for Approval mix designs for SMA, HMA, and PCCP.

10.3.2 Roadway Pavement Types and Thickness Requirements

10.3.2.1 Portland Cement Concrete Pavement

Portland Cement Concrete pavement shall meet compressive or flexural strength requirements as identified in the most current CDOT Standard Specifications for Roadway and Bridge Construction and any currently approved Standard Special Provisions as detailed in Book 2, Section 20. The Contractor shall be responsible for PCCP joint design. The Contractor's joint design shall include tied inside and outside shoulders. Outside and inside mainline shoulders shall include transverse load transfer devices (DC joints). PCCP joint design shall comply with the requirements of Book 3, including but not limited to the CDOT *M & S Standard Plans*, and the 2016 CDOT M-E Pavement Design Manual. The PCCP longitudinal and transverse joint designs shall be compatible with lane and shoulder configurations. The Contractor shall submit the pavement joint design to CDOT for Review and Acceptance. PCCP construction shall not commence until the PCCP Jointing Plan is Accepted.

The Contractor shall texture mainline C-470 outside shoulders per CDOT standards. Station stamping is not required.

10.3.2.2 Pavement Smoothness

The Contractor shall construct the PCCP/flexible pavement for the Project to the smoothness requirements as set forth in Table 10.3.2.6.

Table 10.3.2.6
SMOOTHNESS REQUIREMENTS

Location	Pavement Smoothness Category[(ii)]
Flexible Pavement	HRI Category II (Inches/mile)
Rigid Pavement	HRI Category II (Inches/mile)
Overlay	HRI Category I (Inches/mile)
Proposed Structure	HRI Category II (Inches/mile)

Pavement smoothness requirements shall apply to new shoulders that will be a travel lane in the ultimate configuration. An incentive for pavement smoothness will not be paid.

10.4 Deliverables

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

Deliverables	Review, Acceptance or Approval	Schedule
Supplemental Geotechnical investigation reports	Acceptance	Within 30 Days following completion of the fieldwork
Preliminary Pavement Design Report	Review	As part of the Preliminary Design Plans
Pavement Design Report	Review/Acceptance	As Part Of The Pre-RFC Review Documents and Final RFC Documents Submittals
Paving Quality Control Plan	Approval	At the Pre-Paving Conference and at a minimum of 30 days prior to the planned placement of any SMA/HMA/PCCP on the Project
Preliminary PCCP Jointing Plan	Review	As Part Of The Preliminary Design Plans (30%) Submittal
PCCP Jointing Plan	Review/Acceptance	As Part Of The Pre-RFC Review Documents and Final RFC Documents Submittals
PCCP Mix designs	Approval	At the Pre-paving Conference and at least 30 Days prior to the use of any PCCP on the Project
SMA & HMA mix designs	Approval	At the Pre-Paving Conference and at a minimum of 30 days prior to the planned placement of any SMA/HMA on the Project

Preliminary Pavement Marking Plan	Review	As Part Of The Preliminary Design Plans (30%) Submittal
Pavement Marking Plan	Review/Acceptance	As Part Of The Pre-RFC Review Documents and Final RFC Documents Submittals
Detour Paving Design	Acceptance	At the Pre-paving Conference and at least 14 Days prior to the use of any Detour Pavement on the Project
Planing Plan and Quality Control Plan (QCP)	Approval	At the pre-pave conference and at least 30 days Prior to Beginning Planing Operations
Quality Control Plan Outlining the Steps Taken to Minimize Segregation of HMA	Approval	At the Pre-Paving Conference and at a minimum of 30 days prior to the planned placement of any HMA on the Project
Inlet/Manhole Modifications Plans	Acceptance	Concurrently with Each Applicable Traffic Control Plan (TCP)

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

10.5 Project Special Provisions

The following specifications modify and take precedence over the Standard Specifications.

10.5.1 Removal of Concrete Pavement

Section 202 of the Standard Specifications is hereby revised for this project as follows:

In subsection 202.02 delete the seventh paragraph and replace with the following:

The existing concrete pavement, which varies in thickness, shall be removed in a manner that minimizes contamination of the removed concrete with underlying material. The removed mat shall become the property of the Contractor and be disposed of by any one or more of the following described methods:

1. Use in embankment construction in accordance with subsection 203.06.
2. Place material in bottom of fills as approved by the Engineer.
3. Place material in subgrade soft spots outside of the roadway prism as directed by the Engineer.

10.5.2 Removal of Asphalt Mat

Section 202 of the Standard Specifications is hereby revised for this project as follows:

In subsection 202.02 delete the seventh paragraph and replace with the following:

The existing asphalt mat, which varies in thickness, shall be removed in a manner that minimizes contamination of the removed mat with underlying material. The removed mat shall become the property of the Contractor and be disposed of by any one or more of the following described methods:

1. Use in embankment construction in accordance with subsection 203.06.
2. Place material in bottom of fills as approved by the Engineer.
3. Place material in subgrade soft spots outside of the roadway prism as directed by the Engineer.
4. Recycled into the Hot Mix Asphalt.

10.5.3 Removal of Asphalt Mat (Planing)

Section 202 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 202.09, and replace it with the following:

202.09 Removal of Asphalt Mat (Planing). At the pre-pave conference and at least 30 days prior to beginning planing operations, the Contractor shall submit a planing plan

and Quality Control Plan (QCP) for Approval by CDOT. The planing plan shall include at a minimum:

(1) The number, types and sizes of planers to be used.
(2) The width and location of each planing pass.
(3) The number and types of brooms to be used and their locations with respect to the planers.
(4) The proposed method for planing and wedging around existing structures such as manholes, valve boxes, and inlets.
(5) The longitudinal and transverse typical sections for tie-ins at the end of the day.
(6) If requested by CDOT, a plan sheet showing the milling passes.

The QCP shall include as a minimum:

(1) The schedule for replacing the cutting teeth.
(2) The daily preventive maintenance schedule and checklist.
(3) Proposed use of automatic grade controls.
(4) The surface testing schedule for smoothness.
(5) The process for filling distressed areas.
(6) The schedule for testing macrotexture of the milled surface.
(7) Corrective procedures if the milled surface does not meet the minimum macrotexture specification.
(8) Corrective procedures if the milled surface does not meet the minimum transverse or longitudinal surface finish when measured with a 10 foot straightedge.

The Contractor shall not start the planing operation until the hot mix asphalt (HMA) mix design has been approved and a Form 43 has been signed by CDOT.

The existing pavement shall be milled to the cross-slope as shown on the plans, and shall have a surface finish that does not vary longitudinally or transversely more than 3/8 inch from a 10 foot straightedge. A 10 foot straightedge shall be supplied by the Contractor.

All milled surfaces shall be broomed with a pick-up broom, unless otherwise specified, before being opened to traffic. A sufficient number of brooms shall be used immediately after planing to remove all milled material remaining in the roadway.

If the Contractor fails to adequately clean the roadway, work shall cease until CDOT has approved the Contractor's revised written proposal to adequately clean the roadway.

The milled surface shall have a macrotexture equal to or less than 0.170 inches for single-lift overlays and 0.215 inches for multiple-lift overlays as tested in accordance with CP 77. Milled surfaces that do not meet these criteria shall require corrective action in accordance with the QCP. The Contractor shall be responsible for testing the macrotexture of the milled surface at the location directed by CDOT in accordance with

CP 77 at a stratified random frequency of one test per 10,000 square yards or a minimum of once per work day.

At the completion of each day's work, longitudinal vertical edges greater than 1 inch shall be tapered. No transverse vertical edges will be allowed. Longitudinal milled surface tie-ins to existing pavement shall be tapered to not less than a 3:1 slope, transverse milled surface tie-ins to existing pavement shall be tapered to not less than a 50:1 slope. Transverse tapered joints may be tapered with the planing machine, a temporary asphalt ramp, or other methods approved by CDOT. No longitudinal joint between the milled and existing surfaces shall fall between 1 to 5 feet of any lane line.

If the transverse joint is tapered with a temporary asphalt ramp, the milled surface at the joint shall be constructed as a butt joint the full depth of the lift of asphalt to be placed on the milled surface. The Contractor shall be responsible for maintaining this asphalt ramp until all corresponding HMA is placed. All work associated with this joint will not be paid for separately, but shall be included in the cost of planing.

If the transverse joint is tapered with a planing machine, a butt joint shall be cut into the taper the full depth of the lift of asphalt to be placed on the milled surface prior to commencement of resurfacing. All work associated with this joint will not be paid for separately, but shall be included in the cost of planing.

Other approved transverse joint tapers shall be maintained at the expense of the Contractor, and at a minimum shall incorporate a butt joint the full depth of the lift of asphalt to be placed on the milled surface prior to commencement of resurfacing.

Distressed or irregular areas identified in the planed surface by CDOT shall be patched.

The roadway shall be left in a safe and usable condition at the end of each work day. The Contractor shall take appropriate measures to ensure that the milled surface does not trap or hold water. All required pavement markings removed by the planing shall be restored before the roadway is opened to traffic.

All milled surfaces to be overlaid with HMA shall be covered with new asphalt within 7 calendar days. All areas on this project that are not overlaid within the specified working days will be assessed a lane rental fee of $2000 per occurrence for each day or fraction thereof and any required surface repairs shall be paid for by the Contractor.

All planing shall be completed full width and parallel to the travel lanes before resurfacing commences unless otherwise directed by CDOT.

All material generated by the planing operation shall become the property of the Contractor unless otherwise noted in the Contract.

Add subsection 202.091 immediately following subsection 202.09 as follows:

202.091 Equipment

Each planer shall conform to the following:

The planer shall have sufficient power, traction and stability to maintain an accurate depth of cut. The propulsion and guidance system of the planer shall be maintained in such condition that the planer may be operated to straight and true lines.

The planer shall be capable of operating with automatic grade controls (contact or non-contact) on both sides of the machine using a 30 foot averaging system or other approved grade control systems. The use of such controls shall be described in the Contractor's QCP.

The planer shall be capable of picking up the removed material in a single operation. A self- loading conveyor shall be an integral part of the planer. Windrows will not be allowed.

Subsection 202.12 shall include the following:

Macrotexture testing, macrotexture corrective actions, planers, brooms and all other work necessary to complete the item will not be measured and paid for separately, but shall be included in the work.

10.5.4 Hot Mix Asphalt Compaction

In subsection 401.17, first paragraph, delete the second sentence and replace with the following:

Both steel wheel and pneumatic tire rollers shall be required on this project. If the Contractor has demonstrated to CDOT that all of the manufacturer's recommendations were followed and the pneumatic tire roller is detrimental to the finished HMA surface of the HMA, CDOT, in cooperation with the Contractor and the Region Materials Engineer, may waive the pneumatic tire roller requirement. Pneumatic tire rollers shall not be used on SMA pavement. Steel wheel rollers shall not be operated in vibratory mode on bridge decks.

10.5.5 Conformity to the Contract of Hot Mix Asphalt

Section 106 of the Standard Special Provisions is hereby revised for this Project as follows:

Subsection 106.05 shall include the following:

For this Project, Contractor process control testing of HMA is mandatory.

10.5.6 Aggregate Base Course Class 6

Section 304 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 304.02 shall include the following:

Materials for the base course shall be ABC Class 6 as shown in Subsection 703.03.

The ABC Class 6 must meet the gradation requirements and have a resistance value of at least 78 when tested by the Hveem Stabilometer method. Testing shall be per CP-L 3101 (Resistance R-Value and Expansion Pressure of Compacted Soils or Aggregates by Means of Hveem Stabilometer). Test result documentation for ABC Class 6 used for this project must be provided prior to use on site.

10.5.7 Hot Mix Asphalt

Section 403 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 403.02 shall include the following:

The design mix for HMA shall conform to the following:

Table 403-1

Property	Test Method	Value For Grading			
		S (100)			Patching
Air Voids, percent at: N (design)	CPL 5115	3.5 – 4.5			3.5 – 4.5
Lab Compaction (Revolutions): N (design)		100			100
Stability, minimum	CPL 5106	30			30
Aggregate Retained on the 4.75 mm (No. 4) Sieve with at least 2 Mechanically Induced fractured faces, % minimum	CP 45	70			70
Accelerated Moisture Susceptibility Tensile Strength Ratio (Lottman), minimum	CPL 5109 Method B	80			80
Minimum Dry Split Tensile Strength, kPa (psi)	CPL 5109 Method B	205 (30)			205 (30)
Grade of Asphalt Cement, Top Layer					PG 76-28
Grade of Asphalt Cement, Layers below Top		PG 64-22			PG 64-22
Voids in the Mineral Aggregate (VMA) % minimum	CP 48	See Table 403-2			See Table 403-2

Table 403-1

Property	Test Method	Value For Grading			
Voids Filled with Asphalt (VFA), %	AI MS-2	65-75			65-75
Dust to Asphalt Ratio Fine Gradation Coarse Gradation	CP 50	0.6 – 1.2 0.8 – 1.6			0.6 – 1.2 0.8 – 1.6

Notes:

- AI MS-2 = Asphalt Institute Manual Series 2.
- The current version of CPL 5115 is available from CDOT.
- Mixes with gradations having less than 40% passing the 4.75 mm (No. 4) sieve shall be approached with caution because of constructability problems.
- Gradations for mixes with a nominal maximum aggregate size of one-inch or larger are considered a coarse gradation if they pass below the maximum density line at the #4 screen.
- Gradations for mixes with a nominal maximum aggregate size of 3/4" to 3/8" are considered a coarse gradation if they pass below the maximum density line at the #8 screen.
- Gradations for mixes with a nominal maximum aggregate size of #4 or smaller are considered a coarse gradation if they pass below the maximum density line at the #16 screen.

*Fractured face requirements for SF may be waived by RME depending on project conditions.

All mix designs shall be run with a gyratory compaction angle of 1.25 degrees and properties must satisfy Table 403-1. Form 43 will establish construction targets for Asphalt Cement and all mix properties at Air Voids up to 1.0 percent below the mix design optimum. CDOT will establish the production asphalt cement and volumetric targets based on the Contractor's mix design and the relationships shown between the hot mix asphalt mixture volumetric properties and asphalt cement contents on the Form 429. CDOT may select a different

AC content other than the one shown at optimum on the Contractor's mix design in order to establish the production targets as contained on the Form 43. Historically, Air Voids adjustments typically result in asphalt cement increases from 0.1 to 0.5 percent. Contractors bidding the project should anticipate this change and factor it into their unit price bid.

Table 403-2

	Minimum Voids in the Mineral Aggregate (VMA)			
Nominal Maximum Size*, mm (inches)	*****Design Air Voids ****			
	3.5%	**4.0%**	**4.5%**	**5.0%**
37.5 (1½)	11.6	11.7	11.8	N/A
25.0 (1)	12.6	12.7	12.8	
19.0 (¾)	13.6	13.7	13.8	
12.5 (½)	14.6	14.7	14.8	
9.5 (⅜)	15.6	15.7	15.8	
4.75 (No. 4)	16.6	16.7	16.8	16.9
	* The Nominal Maximum Size is defined as one sieve larger than the first sieve to retain more than 10%. ** Interpolate specified VMA values for design air voids between those listed. *** Extrapolate specified VMA values for production air voids beyond those listed.			

The Contractor shall prepare a quality control plan outlining the steps taken to minimize segregation of HMA. This plan shall be submitted to CDOT for Approval at the Pre-Paving Conference and at a minimum of 30 days prior to the planned placement of any HMA on the Project. When CDOT determines that segregation is unacceptable, the paving shall stop and the cause of segregation shall be corrected before paving operations will be allowed to resume.

HMA for patching shall conform to the gradation requirements for SMA for the top lift and HMA (Grading S) (100) (PG 64-22) for intermediate and lower lifts. All patching determinations shall be the responsibility of the Contractor with consultation with CDOT.

CDOT approved Warm Mix Asphalt (WMA) may be allowed on this project in accordance with CP-52 and CP-59. WMA mixes shall utilize additives from the CDOT Approved Products List (APL). Unique requirements for WMA design, production and acceptance testing as documented during CDOT WMA approval shall be submitted and approved prior to creation of the Form 43 and before any WMA production on the project. Any delays to the project due to WMA submittal and review shall be considered within the Contractor's control and will be non-excusable.

A minimum of 1% hydrated lime by weight of the combined aggregate shall be added to the aggregate for all HMA.

Subsection 403.03 shall include the following:

The Contractor shall use an approved anti-stripping additive. The amount of additive used shall be a minimum of 0.5 percent by weight of the asphalt cement. The additive shall be added at the refinery or at the hot plant. If liquid anti-stripping additive is added at the plant, an approved in-line blender must be used. The blender shall be in the line from the storage tank to the drier drum or pugmill. The blender shall apply sufficient mixing action to thoroughly mix the asphalt cement and anti-stripping additive.

The Contractor shall construct the Work such that all roadway pavement placed prior to the time paving operations end for the year, shall be completed to the full thickness required by the plans. The Contractor's progress schedule shall show the methods to be used to comply with this requirement.

Aggregate, asphalt recycling agent, asphalt cement, additives, hydrated lime, and all other work and materials necessary to complete each hot mix asphalt item will not be paid for separately, but shall be included in the unit price bid. When the pay item includes the PG binder grade, any change to the submitted mix design optimum asphalt cement content to establish production targets on the Form 43 will not be measured and paid for separately, but shall be included in the work. No additional compensation will be considered or paid for any additional asphalt cement, plant modifications and additional personnel required to produce the HMA as a result in a change to the mix design asphalt cement content.

Historically, typical asphalt cement increases reflected on the Form 43 are from 0.1 to 0.5 percent. However, the Contractor should anticipate the AC increases typical of his mixes. Contractors bidding the project should anticipate this change and factor it into their unit price bid.

When the pay item does not include the PG binder grade, asphalt cement will be measured and paid for in accordance with Section 411. Asphalt cement used in Hot Mix Asphalt (Patching) (Asphalt) will not be measured and paid for separately, but shall be included in the work.

Excavation, preparation, and tack coat of areas to be patched will not be measured and paid for separately, but shall be included in the work.

10.5.8 Stone Matrix Asphalt Pavement

Sections 401 and 703 of the Standard Specifications are hereby revised for this Project as follows:

Subsection 401.02 shall include the following:

Recycled Asphalt Pavement (RAP) shall not be used in Stone Matrix Asphalt (SMA) mix.

Subsection 401.09 shall include the following:

Each SMA load shall be completely covered and securely fastened with a full tarp.

Subsection 401.16 shall include the following:

The SMA mixture shall be transported and placed on the roadway without drain-down or flushing. All flushed areas behind the paver shall be removed immediately upon discovery. If more than 50 square feet of flushed SMA pavement is ordered removed and replaced in any continuous 500 linear feet of paver width laydown, operations shall be discontinued until the source of the flushing has been found and corrected. CDOT shall designate the depth and area of all flushed areas requiring removal and replacement. All costs associated with the removal and replacement of the flushed areas shall be at the Contractor's expense.

Subsection 401.17 shall include the following:

Rollers shall not be used in a vibratory mode on SMA unless they are first used successfully in the demonstration control strip specified in subsection 403.03. Pneumatic wheel rollers shall not be used on SMA mix.

Stone Matrix Asphalt Pavement shall be placed and compacted in accordance with the temperatures listed in subsection 401.07.

The relative compaction for all SMA mixtures will be measured from roadway cores in accordance with CP 44, Method B, unless the SMA mixture is being placed on a structure (bridge deck) in which case nuclear gauge measurements may be used.

When cores are used, the Contractor shall provide all labor and equipment for the coring operation and filling the core holes. When nuclear density gauges are used, the tests will be performed in accordance with CP 81 and CP 82.

In-place density for SMA not placed on a bridge shall be 93 to 97% of the SMA mix maximum specific gravity as measured according to CP 51.

At a minimum frequency of once per day, the in-place density for SMA placed on the bridge deck shall be measured according to CP 81. The in-place density of SMA shall be a minimum of 94 percent of the SMA mix maximum specific gravity as measured according to CP 51

Subsection 401.22 shall include the following:

Acceptance, testing, and pay factors for SMA shall be in accordance with subsections 105.05 and 106.05 as revised for this Project for HMA. The specifications for gradation acceptance shall be applied for all SMA placed on the project.

Subsection 703.06 shall include the following:

Mineral filler for the Stone Matrix Asphalt pavement shall be limestone dust and shall meet the requirements of this subsection and the following:

Plasticity Index (AASHTO T90) 4% Maximum

The Contractor shall submit hydrometer analysis (AASHTO T88) for the mineral filler used in the SMA mix.

Section 403 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 403.01 shall include the following:

This work includes placing a Stone Matrix Asphalt (SMA) pavement as shown on the plans.

Subsection 403.02 shall include the following:

The SMA gradation for this Project shall be ½ inch.

Mixture design and field control testing of SMA shall be performed using either the SuperPave (CPL 5115, 100 Gyrations) or the Marshall Method (AASHTO T245, 50 Blow).

A minimum of 30 days prior to the proposed use of any Stone Matrix Asphalt pavement on the project, a pre-paving conference will be conducted. At that time, the Contractor shall submit to CDOT, a mix design meeting the appropriate specification requirements for one of the following:

The SuperPave SMA mix design shall conform to the requirements of Table 403-1a:

Table 403-1a

Property	Test Method	Value for SMA
Air Voids, percent at: N(Design)	CPL 5115	3.0 – 4.0
Lab compaction (Revolutions) N(Design)	CPL 5115	100
Accelerated Moisture Susceptibility, tensile strength Ratio, (Lottman), minimum	CPL 5109, Method B	70
Minimum Dry Split Tensile Strength, psi	CPL 5109, Method B	30
Grade of Asphalt Cement		PG 76-28
Voids in the Mineral Aggregate (VMA) %, minimum	CP 48	17
Draindown at Production Temperature	AASHTO T305	0.3 maximum
% VCA^{1}_{MIX}	AASHTO R 46	Less than VCA_{DRC}[2]

Note: The current version of CPL 5115 is available from CDOT
Note: Copies of AASHTO R 46 and M 325 can be obtained from CDOT
Note: [1]Voids in the Coarse Aggregate
Note: [2]Dry-rodded condition

Form 43 will establish construction targets for asphalt cement and all mix properties at air voids up to 1.0 percent below the mix design optimum. CDOT will establish the production asphalt cement and volumetric targets based on the Contractor's mix design and the relationships shown between the Stone Matrix Asphalt mixture volumetric properties and asphalt cement contents on the Form 429. CDOT may select a different AC content other than the one shown at optimum on the Contractor's mix design in order to establish the production targets as contained on the Form 43. Historically, Air Voids

adjustments typically result in asphalt cement increases from 0.1 to 0.5 percent. Contractors bidding the project should anticipate this change and factor it into their unit price bid.

The Marshall SMA mix design shall conform to the following:

Mix Properties	Value
Stability, Marshall Compactor	1400 lbs., min
% Voids in Total Mix	3 – 4%
VMA (% Voids in the Mineral Aggregate)	17 min.
Lottman, CP-L 5109, Method B	70% min
Dry Tensile Strength, (CP-L 5109)	30 psi, min.

Regardless of mix design method, a minimum of 1% hydrated lime by weight of the combined aggregate shall be added to the aggregate for all Stone Matrix Asphalt.

The SMA mix design must be Approved by CDOT before any pavement is placed on the project. In addition, the Contractor shall provide field control testing during production of the SMA mix and for the demonstration control strip. The Contractor shall perform the following tests and provide the results to CDOT during production:

If a Superpave SMA mix design is used, the Contractor shall perform the following tests and provide the results to CDOT during production:

Superpave Mix Property	Frequency
Draindown (AASHTO T 305)	1/1000 tons or fraction thereof
Percent Voids in the total mix @ $N_{(design)}$	1/1000 tons or fraction thereof
VMA (Percent Voids in the Mineral Aggregate) @ $N_{(design)}$	1/1000 tons or fraction thereof
Lottman, CPL 5109, Method B	1/5000 tons or fraction thereof
Dry Tensile Strength, CPL 5109	1/5000 tons or fraction thereof
Percent AC & Aggregate Gradation CP 5120	1/1000 tons or fraction thereof

If a Marshall SMA mix design is used, the Contractor shall perform the following tests and provide the results to CDOT during production:

Marshall Mix Property	Frequency
Draindown (AASHTO T 305)	1/1000 tons or fraction thereof
Stability (Marshall)	1/1000 tons or fraction thereof
Percent Voids in the total mix	1/1000 tons or fraction thereof
VMA (Percent Voids in the Mineral Aggregate)	1/1000 tons or fraction thereof

Marshall Mix Property	Frequency
Lottman, CPL 5109, Method B	1/5000 tons or fraction thereof
Dry Tensile Strength, CPL 5109	1/5000 tons or fraction thereof
Percent AC & Aggregate Gradation CP 5120	1/1000 tons or fraction thereof

CDOT approved Warm Mix Asphalt (WMA) may be allowed on this project in accordance with CP-52 and CP-59. WMA mixes shall utilize additives from the CDOT Approved Products List (APL). Unique requirements for WMA design, production and acceptance testing as documented during CDOT WMA approval shall be submitted and approved prior to creation of the Form 43 and before any WMA production on the project. Any delays to the project due to WMA submittal and review shall be considered within the Contractor's control and will be non-excusable.

Subsection 403.03 shall include the following:

The mineral filler for SMA shall be stored in a separate silo and added automatically in the correct proportion. The mineral filler addition equipment shall be electronically or mechanically interlocked to the aggregate feed sensors so that the proper amount of mineral filler is added whenever SMA is produced.

The SMA mineral filler shall be added at the same point the asphalt cement is added to the aggregate.

Tack coat between the existing pavement and Stone Matrix Asphalt pavement shall be placed at a rate between 0.03 and 0.05 gallons per square yard.

Before proceeding with SMA placement, the Contractor shall demonstrate the ability to produce and place a satisfactory mix in a Demonstration Control Strip (DCS). The Contractor will coordinate with the Quality Control Manager on the proposed location of the DCS. The DCS shall consist of a minimum quantity of 500 tons placed in one lane, full width. Within the last 200 tons of SMA placed in the DCS, the Contractor and CDOT shall determine properties (VMA, Voids, in-place density, AC content, gradation, and Marshall Stability, if required) of the project produced SMA mix used in the DCS and provide the results to the Contractor's Quality Control Manager. The Contractor may proceed with full production if all mixture properties are within the specified tolerances and the project compaction is established and approved by CDOT.

If a DCS will be placed on the actual roadway, it shall be full width and shall extend for a minimum distance of 150 feet. The location of the DCS shall be no closer than 100 feet to the expansion joint of any bridge with concurrent deck rehabilitation or construction.

To determine the in-place density and roller pattern, one core shall be taken at three random locations within the last 200 tons of the DCS. As part of the Contractor's QMP, the coring locations shall be determined using a stratified random sampling process. The cores shall be immediately submitted to the Contractor's Quality Manager and will be used for determining acceptance of the DCS. Densities of the random samples will be determined by cores according to CP 44. Coring shall be performed by the Contractor under the Quality Manager's observation.

The DCS will be designated as a separate process.

Subsection 403.04 shall include the following:

Stone Matrix Asphalt will be measured by the actual number of tons that are completed and accepted.

Subsection 403.05 shall include the following:

Mix design, furnishing, hauling, preparing, and placing all materials, including aggregates, asphalt cement, limestone dust, alternate mineral filler, hydrated lime, tack coat, and approved demonstration control strip; labor, equipment tools, setting of lines and guides where specified, and all other work and materials necessary to complete the item will not be paid for separately but shall be included in the unit bid price. Any change to the submitted mix design optimum asphalt cement content to establish production targets on the Form 43 will not be measured and paid for separately, but shall be included in the work. No additional compensation will be considered or paid for any additional asphalt cement, plant modifications and additional personnel required to produce the HMA as a result in a change to the mix design asphalt cement content. Historically, typical asphalt cement increases reflected on the Form 43 are from 0.1 to 0.5 percent. However, the Contractor should anticipate the AC increases typical of his mixes. Contractors bidding the project should anticipate this change and factor it into their unit price bid. Stone Matrix Asphalt will be measured by the actual number of tons that are completed and accepted.

10.5.9 Detour Pavement

Detour Pavement shall also conform to the requirements of Book 2, Section 16, Transportation Management Plan.

Section 621 is hereby added to the Standard Specifications for this Project and shall include the following:

621.01 This work consists of design and construction of detour pavement as shown in the plans for all phases of construction on C-470, all applicable ramps, and all affected roadways requiring detour pavement; maintenance of the detours; removal of the detours; and removal and replacement of appurtenances required to construct and operate the detours including but not limited to guardrail, curb and gutter, detour pavement, embankment material and unclassified excavations.

621.02 All materials required for detour shall comply with project standard specifications and special provisions.

The Contractor shall be responsible for quality control required to assure adequate quality of embankment material, aggregate base course, PCCP, and HMA used in the construction of the detour.

The Contractor shall provide smooth pavement transitions between new and existing roadways. Grade differences shall not exceed 4 percent break-over. Transverse joint tapers shall be 20 feet horizontal to 1 inch vertical, or flatter. Longitudinal joints which have a vertical drop-off shall be tapered with Hot Mix Asphalt. Tapers shall be 8 horizontal to 1 vertical or flatter.

The finished transverse and longitudinal surface elevation of the detour pavement shall be measured by the Contractors Process Control Team during placement using a 10-foot straightedge and depth gauge. Areas to be measured will be directed by the Contractors ICQC Team. Additional measurements shall be taken by the Contractors Process Control Team as requested by CDOT to address areas of potential nonconformance. Areas showing high spots of more than ¼ inch in 10 feet shall be reworked during placement or marked and diamond ground if discovered after placement until the high spot does not exceed ¼ inch in 10 feet.

Where detour traffic will run over existing or new drainage inlets or manholes, the inlets or manholes shall be modified by the Contractor to provide a level riding surface. Inlet grates and manhole covers shall be securely fastened to the inlet using methods and materials capable of resisting cyclical vehicular and dynamic impact loads. Grate/cover conditions shall be checked by the Contractor daily, and shall be re-fastened immediately if found to be loose, or repaired if damaged. Plans for inlet or manhole modifications shall be signed and sealed by the Contractors Engineer and shall be submitted to CDOT for Acceptance concurrently with each applicable Traffic Control Plan (TCP). When detour traffic will no longer run over the modified inlets or manholes, the inlets or manholes will be modified as necessary to meet the permanent design configuration. All modification work and materials to accommodate detour conditions and subsequent modifications for permanent conditions, shall be included in the cost of Detour Paving, and will not be paid for separately.

621.03 The detour locations and dimensions for all phases of construction shall be as shown on the plans.

If the materials and thickness furnished for the detour pavement result in an inadequate detour structure, the Contractor will provide additional thickness, materials, or other measures necessary to provide a satisfactory pavement for the life of the detour. These additional improvements shall be furnished at no additional cost. All necessary signs, pavement markings and other traffic control devices shall be provided in accordance with the traffic control plan.

621.04 The Contractor shall maintain the detour for the entire period that it is open to traffic. Any distress that affects the ride, safety, or serviceability of the detour roadway shall be corrected to the satisfaction of the CDOT at the expense of the Contractor.

The Contractor shall have a maintenance plan for all hours of the day (7 days a week) for executing a long term patch of damaged detour pavement, and have forces available to perform this work within 2 hours of notice of such damage. The Contractor shall designate a person to be “on call” during all non-working hours, including no work periods as a point of contact for this work.

If CDOT determines the detour has deteriorated to the point where the safety of the traveling public is compromised (i.e. potholes), the lane(s) in question shall be closed and the Contractor shall be directed to execute their maintenance plan. If the Contractor is unresponsive to this order by CDOT, CDOT maintenance forces will be mobilized to close the lane and maintain the closure until such time as the Contractor is available to perform this work. CDOT Maintenance forces will be responsible for the lane closure only, and only until such time as the Contractor arrives on site and relieves them. CDOT

Maintenance will not be responsible for repair of any of the contract installed detour. All time and expense for CDOT Maintenance work will be tracked by CDOT and deducted from money due to the Contractor. Any lane closures that are required outside of the allowable lane closure hours will be charged as 'working time violation' as established in this contract.

11.0 EARTHWORK

11.1 Construction Requirements

11.1.1 Removal of Structures

The Contractor shall raze, remove, and dispose of all structures and obstructions which are identified on the Project for removal, except utilities and structures and obstructions removed under other contractual agreements, and salvable material designated to remain the property of the
Department.

Substructures of existing structures, regardless of location, shall be removed a minimum of one (1) foot below the existing natural ground surface or the proposed ground surface, whichever is at a lower elevation, and a minimum of five (5) feet horizontally from proposed underground structures if a conflict exists.

11.1.2 Clearing and Grubbing

The trees, logs, limbs, stumps, brush, trash, and other unsuitable materials cleared and grubbed from the Project shall be removed from the Site to an off-Site location by the Contractor.
The Contractor shall conduct a landscape walkthrough prior to the start of any construction activities according to requirements of Book 2, Section 17 – Landscaping.

11.1.3 Excavations and Embankments

New embankment shall be benched into the existing slopes, where required, in accordance with Section 203.06 of the Standard Specifications.

11.1.3.1 Protection of Processed Soil

A large amount of existing soil will be processed in-place. The contractor shall provide a method to protect soil that has been processed so that it does not become over wetted and unworkable. If treated soil becomes over wetted, i.e. exposure to surface runoff or a temporary drainage condition, the contractor shall be responsible for returning the soil to an acceptable condition prior to lime treatment or placement of pavement, at the sole expenses of the Contractor.

11.1.4 C-470 Mainline, New Auxiliary Lanes and Ramps Swell Mitigation Measures

Treatment of expansive soils is addressed in Section 4.9 of the CDOT 2016 ME Pavement Design Manual, (Manual). CDOT requires treatment of expansive soils on all interstate highways and CDOT's treatment of expansive soils is based on plasticity index (PI). The most likely PI range of the soils from C-470 is between 20 and 30. A-7-6 and A-6 soils make up approximately 79% of the samples tested from C-470 and account for most of the high PI soils. Based on Table 4.8 of the Manual, areas with PIs between 20 and 30 require a minimum of 3 feet of moisture treatment or replacement with impermeable soil.

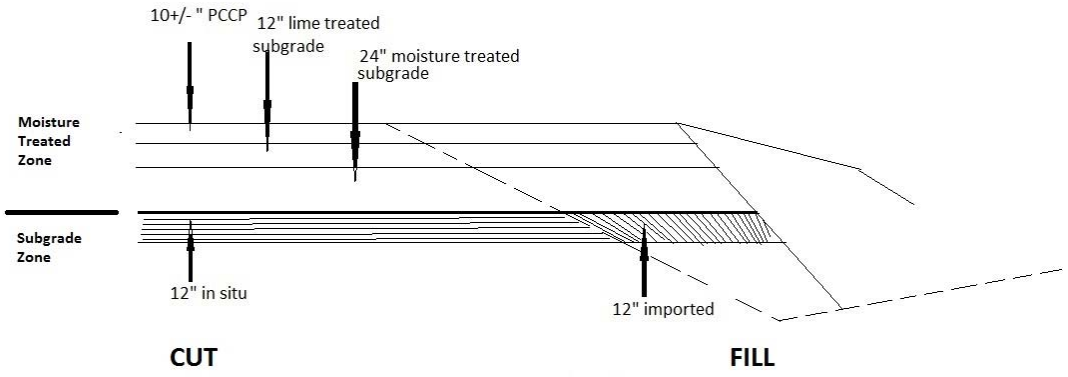
All pavements constructed on widened or realigned areas require a separation of a minimum of three feet of suitable processed material between any untreated subgrade and the bottom of any pavement or ABC.

11.1.4.1 Procedure to Address High PI and Swelling Soils

11.1.4.1.1 Purpose - To provide a procedure for constructing the zone of material two to three feet below the bottom of the pavement section.

11.1.4.1.2 Scope - This procedure applies to all Mainline and Ramps except for roads belonging to local jurisdictions in which their specifications apply.

11.1.4.1.3 Cross Section



11.1.4.1.3 Definitions

Lime treated subgrade – Refers to the 12 inches of material directly under the concrete pavement. The material can be in situ, imported and/or processed on site. The soil will be treated in accordance with Section 307 of the 2011 CDOT Standard Specifications.

Moisture treated subgrade - 2 feet minimum of moisture conditioned soil directly under the 1 foot of lime treated soil and when placed shall have a swell potential of less than 1 percent (%) when tested with a 200 psf surcharge.

Subgrade zone – Refers to the material directly under the 3 feet of moisture conditioned soil. The material can be existing, imported and/or processed on site and shall have a swell potential of less than 1% when tested with a 400 psf surcharge. The soil in the subgrade zone shall be treated per Section 203 of the 2011 CDOT Standard Specifications.

Swell Test – The C-470 mainline and ramp designs require that the soils shall have a percent swell less than or equal to 1% to a depth of three feet below the bottom of the concrete pavement. A percent swell less than or equal to 1% corresponds to a low probability of swell damage risk in that layer. The swell tests will be performed using California tube samples of project placed, moisture conditioned and compacted material.

Alternative Treatment – A proposed soil treatment other than Section 203 of the 2011 CDOT Standard Specifications.

11.1.4.1.4 Responsibilities - Acceptance testing as defined in subsection D. will be performed by the Contractor's ICQC team.

11.1.4.1.5 Procedure

A. *Existing Soils* - Based on existing soil information referenced in the Yeh and Associate's Preliminary Pavement Subsurface Investigation Report, August 19, 2015, the existing soil at the subgrade depth is comprised primarily of clay materials classified as A-7-6 and A-6 soils.

B. Alternate Mitigation of Existing Soils - In order to meet the design requirements, any proposed mitigation measures must result in a percent swell of less than or equal to 1% as defined in subsection D.

B1. Moisture Condition (Fill Section) - The swell potential of the material may be reduced by moisture treatment. In order to reduce the swell potential in the types of clay expected to be encountered, the material must be compacted at or over optimum moisture content. It is acknowledged that at these moisture contents, a proof roll will not be required. "Density" (minimum specified relative density) is required to be met throughout the entire section. Moisture Density Tests for this area shall be a minimum of 1 per 2,000 SY per lift.

The material will be moisture conditioned using a method and equipment proposed by the contractor and Approved by the Engineer. The maximum lift thickness for processed material will be 8 inches loose thickness, except for Lime Treated Subgrade. The requirements of Section 203 of the 2011 CDOT Standard Specifications will be followed.

B2. *Moisture Condition (Cut Section Under Existing Pavement)* - In a cut section, the subgrade zone may be left in place if the in-situ moisture content is above or equal to the optimum moisture as determined by proctor value (AASHTO T99 or T1557) and the swell is demonstrated to be less than 1%. If the subgrade zone of material is shown to meet contractual requirements for swell, the grade will be excavated to the top of the subgrade zone, left in its in-situ condition, and capped so the underlying material will not dry out. It is preferred that the subgrade zone of material be capped the same day as exposed. The subgrade zone shall not be exposed for more than two days.

Cut areas where the in-situ material is less than optimum moisture content and/or shown to have a swelling potential greater than 1% will be treated in accordance with subsection B3. Proof roll requirements will be the same as described in subsection B3. Density tests will be performed as described in subsection D1.

B3. *Moisture Condition (Cut Section No Existing Pavement)* – The swell potential of the material may be reduced by moisture treatment. In order to reduce the swell potential in the types of clay expected to be encountered the material must be compacted at or over optimum moisture content. It is acknowledged that at this moisture content a proof roll will not be required. A proof roll will be performed on the final lift of Lime treated material in conformance with Section 307 of the 2011 CDOT Standard Specifications. Density is required to be met throughout the entire section. Moisture Density Tests for this area shall be a minimum of 1 per 2,000 SY per lift.

The material will be moisture conditioned using a method and equipment proposed by the contractor and Approved by the Engineer. The maximum lift thickness for processed material will be 8 inches loose thickness, except for Lime Treated Subgrade. The requirements of Section 203 of the 2011 CDOT Standard Specifications will be followed.

B4. *Remove and Replace Cut Section* - In limited areas on the project, it is expected that the subgrade material will not be workable and/or exhibit a swell potential that cannot be mitigated by the above proposed measures. In these areas the entire subgrade zone will be excavated and replaced with new material. The new material may be existing material on site or imported material. If the material is clay it will be treated per subsection B1.

C. *Identification of Materials* – The Yeh and Associate's Preliminary Pavement Subsurface Investigation Report, August 19, 2015 and the Contractor's additional soil survey will provide a description of the general soil types expected to be encountered on this project.

D. *Acceptance Testing* – All acceptance testing will be performed in accordance with the Approved Quality Management Plan and the CDOT 2016 Field Materials Manual. The following tests will be performed at the following frequencies.

D1. *Compaction* – Compaction testing is performed at frequencies listed in the Approved QPM and the CDOT 2016 Field Materials Manual.

D2. *Moisture Test – In-situ Cut Section* – One test per lane of roadway every 1000 lineal feet or fraction thereof determined by proctor value (AASHTO T99 or T1557).

D3. *Swell Test*

D3a. Fill Section (B1.) and Cut Section with no existing pavement (B3.)

A test section will be performed by the contractor prior to production swell mitigation. This test section will consist of 2,000 lineal feet of roadway. The entire test section will be moisture conditioned and compacted by the Contractor's proposed method and 6 acceptance swell tests will be performed. The purpose of this section is to provide confidence in the proposed swell mitigation. The test section will be acceptable when 6 consecutive swell tests result in a percent swell of less than or equal to 1%.

Upon completion of the test section, each layer of moisture conditioned soils placed in the above areas will be tested at a frequency of 1 test per 4,000 ft. by 24 ft. of roadway.

The swell mitigation measures will be considered acceptable if the rolling average of the 5 most recent test results is below 1% with no single test value higher than 1.5%.

*If either of these values are exceeded, swell test shall be performed per 1,000 ft by 24 ft until 4 consecutive tests result in a percent sell of less than or equal to 1%.

D3b. Cut Section Under Pavement – Swell tests will be taken during the soil classification survey.

In areas represented by swell tests taken during the soil classification survey showing results less than 1%, moisture and density testing (at the frequency defined in subsection D2.) will be performed prior to placement of the next lift to verify that the material has remained at or above optimum moisture. If the material has dried to below optimum, it shall be moisture treated and recompacted. No additional swell testing will be required.

Areas represented by swell tests showing results greater than 1% shall be mitigated in accordance to an Approved method and will be tested for swell as defined in subsection D3a.

D4. *Soil Classification* – Atterberg Limit and Percent less than No. 200 sieve or gradation to classify the soil as part of soil survey, at a frequency as defined in the QMP and the CDOT 2016 Field Materials Manual.

D5. *Proof Roll* – Top of Lime Treated Subgrade

D6. *Moisture Density Test* – moisture Density testing is performed at frequencies noted in the QMP and the CDOT 2016 Field Materials Manual, except as changed above.

11.1.4.2 Lime Treatment

When lime treating the subgrade, the top three feet of soil shall be moisture treated and then the top foot be treated with the appropriate amount of lime to meet the requirements of Section 307 of the CDOT 2011 Standard Specifications for Road and Bridge Construction.

11.1.4.3 Soil Survey

The Contractor shall utilize the soils information included in Book 3 - Reference Documents and conduct a supplemental soil survey to confirm/ascertain whether the existing roadway soil satisfies the above conditions if it is desired to re-use the on-site materials in the “roadway prism”. This supplemental soil survey in conjunction with the soil survey in Book 3 shall conform to the requirements as stated in the 2016 CDOT Field Materials Manual. The Contractor shall provide any additional mitigation required as a result of the supplemental soil survey.

The results of the supplemental soil survey, along with any additional mitigation measures required, shall be submitted to CDOT for Approval before any embankment, aggregate base course, pavement and pavement related Work commences. The above information shall be submitted in a report format that clearly and concisely describes the existing soil conditions, delineates areas needing additional mitigation, and defines the required mitigation measures. The report shall include a soil profile, boring log, and the test results.

If the on-site materials are re-used, the material will be tested as stated in the 2016 CDOT Field Materials Manual during construction

Where Roadway embankment is retained by structurally designed walls (retaining walls), the retained embankment material properties must be compatible with the soil parameters used in design of the walls. This applies to both externally stabilized and internally stabilized wall systems.

All Work shall be conducted per the 2016 CDOT Pavement Design Manual and the 2016 CDOT Field Materials Manual.

Alternative subgrade treatment shall be submitted to CDOT for Approval a minimum of 30 days before any embankment, aggregate base course, pavement, and pavement related Work commences.

11.1.5 Trails

Trails shall be underlain by 4 inches of ABC Class 6 material and 24 inches of subgrade moisture treatment and recompaction. The ABC Class 6 material and the subgrade moisture treatment/recompaction shall extend to the outer limits of the bikeway pavement, plus one foot on each side.

11.1.6 Compaction Requirements

The type of compaction for the Project shall be per the 2011 CDOT Standard Specifications unless superseded by project special provisions with depth of moisture-density control as follows:

1. Full depth of all embankments
2. Six (6) inches for bases of cuts and fills unless otherwise specified.
3. Thirty-six (36) inches underneath the proposed pavement section (pavement/base course) in all areas except overlay sections of existing pavement.
4. Compaction shall comply with AASHTO T-180 or T-99 testing procedures per the Revision of Section Revision of Sections 203, 206, 304 and 613 – Compaction

5. Any applicable Standard Special Provisions as referenced in Book 2 Chapter 20.

11.1.7 Reuse of Materials

The Contractor is allowed to use broken concrete that is less than 6 inches in maximum dimension or broken asphalt that is less than 6 inches in maximum dimension for embankment material provided it is placed in accordance with Section 203.06 of the Standard Specifications unless otherwise noted. The contractor shall assume all the risk for materials placed in embankments and potential conflicts with the proposed landscaping, utilities, drainage and other sub surface features.

A minimum of 2 weeks before any embankment, aggregate base course, pavement and pavement related Work commences, the Contractor shall submit a proposal to use broken concrete, broken asphalt, or asphalt millings as embankment material. The proposal shall include specific locations, methods, and Quality processes for processing and placement of material in compliance with the contract requirements for reuse of materials.

The Approved locations for all buried broken concrete, broken asphalt, or asphalt millings shall be clearly delineated on the As-Built Documents.

Asphalt millings are allowed to be used for embankment material and shall be placed in accordance with the Standard Specifications and any relevant standard special provisions. Asphalt millings will not be allowed within the top 2 feet of embankment material immediately below the proposed Pavement Structure or as a substitute for aggregate base course within the Pavement Structure without prior written Approval from CDOT.

With Approval of CDOT, the existing subgrade may remain in place if it meets all other requirements herein, before any embankment, aggregate base course, pavement and pavement related Work commences.

11.1.8 Available Potential Source of Material

An available potential source of material has not been identified for this Project.

11.2 Deliverables

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

Deliverable	review, Acceptance or Approval	Schedule
Alternative subgrade treatment	Approval	Proposal shall be submitted a minimum of 30 days before any embankment, aggregate base course, pavement, and pavement related Work commences
Use of broken concrete or broken asphalt or asphalt millings as embankment Material	Approval	Proposal shall be submitted a minimum of 2 weeks before any embankment, aggregate base course, pavement and pavement related Work commences
Existing subgrade allowed to remain in place	Approval	Proposal shall be submitted a minimum of 30 days before any embankment, aggregate base course, pavement and pavement related Work commences
Supplemental Soil Survey and Additional Mitigation Measures	Approval	Prior to submittal of Pavement Design Report and before any embankment, aggregate base course, pavement and pavement related Work commences
Method & Equipment for Moisture Conditioning	Approval	Proposal shall be submitted a minimum of 2 weeks before any embankment, aggregate base course, pavement and pavement related Work commences
Lime Treated Subgrade Mix Design	Approval	Prior to constructing the lime treated subgrade test section

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

11.3 Exhibits

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12.0 Drainage

The Project shall include all Work for the modification of existing drainage facilities, construction of new drainage facilities, construction of water quality facilities and construction of new bridges to accommodate design flows for the Interim and Ultimate Configurations of the C-470 highway. Work shall be completed to meet Project goals and design criteria, and comply with the terms and conditions of the CDOT Municipal Separate Storm Sewer System (MS4) Permit and the MS4 Permits held by the jurisdictions adjacent to the Project. Jurisdictions adjacent to the project with MS4s include: Jefferson County, Douglas County, Highlands Ranch Metropolitan District (HRMD) and Lone Tree (Lone Tree). Work shall also satisfy the commitments described in; Reference Documents, third party agreements (Book 2, Section 6), this Section 12 and all other applicable permits and standards, included in the Contract Documents.

The Revised Environmental Assessment (REA), Hydraulic Study (HS), Water Quality Technical Report (WQTR) and 30% Design Drainage Report (DDR), are included in the Reference Documents. These materials provide information regarding flood detention facilities, stormwater quality treatment, regulatory floodplains, onsite and offsite drainage basins, design flows, and a conceptual layout of the proposed drainage and permanent water quality systems, for informational purposes. The conceptual plan represented in these documents is based on the proposed Ultimate Configuration.

All drainage improvements constructed for the Project shall be designed so that they achieve goals and comply with design criteria applied to both for the Basic Configuration and the Ultimate Configuration for the Project. The drainage design will be compatible with the geometric design of the Basic Configuration at points of initial collection of stormwater flows, where the collection system needs to be different from the Ultimate Configuration (primarily median ditches and inlets). At all other locations, and for the overall system capacity drainage will fully accommodate the Ultimate Configuration. Interim improvements shall be designed and constructed to limit reconstruction of improvements completed for the Basic Configuration are required to complete the drainage system for the Ultimate Configuration. Interim improvements must provide best value to the project in consideration of both the initial Basic Configuration and the Ultimate Configuration.

The Contractor shall design and construct a complete drainage system to intercept and remove surface runoff from C-470, maintain surface, channel, and conduit flow through the Right-of-Way (ROW), and convey flows crossing C-470 under bridges and through cross drains. The drainage system shall be designed and constructed to also manage subsurface flows to avoid saturation of subgrade materials that support the roadway and its associated structures. The Contractor shall also design and construct the drainage facilities to limit drainage-related hazards within and outside the ROW, while minimizing future operation and maintenance costs, public inconvenience, flood damages, and water quality impacts during construction.

All existing cross drains, storm drains, and drainage appurtenances within the Project shall be removed and replaced with an adequate drainage system, except for concrete box culverts and storm drains as shown on the DDR. Existing storm drains within S. Sante Fe Drive, Lucent Boulevard, Broadway, Colorado Boulevard, University Boulevard, S. Quebec St. Green Acres Dr. and Yosemite St. shall remain in place.

The Contractor shall design drainage facilities to be compatible with existing or proposed drainage systems on adjacent properties, and shall preserve existing drainage patterns wherever possible. The Contractor shall obtain approval from affected Local Agencies for any proposed on-site drainage improvements that connect to existing storm drains, upstream or downstream of the Project. If existing drainage patterns must be changed, or if peak flow rates increase above pre-project peak flow rates, due to design of the Project, the Contractor shall design and construct a solution that does not adversely impact property owners outside the CDOT ROW or easement areas, shall obtain Approval from CDOT prior to construction, and where drainage patterns or amounts are changed from existing, the Contractor shall secure all other necessary Approvals, permits, and additional easements.

12.0.1 Standards

The Contractor shall design and construct the drainage system within project right-of-way to comply with the CDOT Drainage Design Manual (DDM), except where otherwise stated in these technical requirements, and the Contract Documents. Outside of the project right-of-way, the Contractor shall design and construct the drainage system to comply with the governing local jurisdiction criteria. Where design criteria is not specifically addressed in these technical requirements, the DDM, or the local jurisdiction criteria, the design shall be in accordance with the latest version of the standards listed in Table 12.0-1. Where standards conflict, the more stringent standard shall apply.

TABLE 12.0-1
STANDARDS FOR DRAINAGE

Author or Agency	Title
CDOT	*Book 2 Section 20, Modifications to Standard Provisions*
CDOT	*Standard Specifications for Road and Bridge Construction*
CDOT	*Standard Plans, M & S Standards*
CDOT	*Drainage Design Manual (DDM)*
CDOT	*Bridge Design Manual, Section 16 – Hydraulics and Drainage*
UDFCD	*Urban Storm Drainage Criteria Manual, Volumes I, II and III (USDCM)*
CDOT	*Erosion Control and Storm Water Quality Guide*
CDOT	*2014 Interim New Development Redevelopment, as amended by CDPHE on January 8, 2015 (2014 NDRD)*
Douglas County	*Douglas County Storm Drainage Design and Technical Criteria*
Douglas County	*Grading, Erosion and Sediment Control Manual (GESC)/Drainage Erosion and Sediment Control (DESC) Manual*
Jefferson County	*Storm Drainage Design & Technical Criteria*

12.0.2 Design Guidelines

Where the above standards do not address a certain design criteria or elements, the design guidelines listed in Table 12.0-2 shall be utilized. Where guidelines conflict, the more stringent shall apply.

TABLE 12.0-2
DESIGN GUIDELINES FOR DRAINAGE

Author or Agency	Title
AASHTO	*A Policy on Geometric Design of Highways and Streets*
FHWA	*Hydraulic Design of Energy Dissipaters for Culverts and Channels, HEC-14*
FHWA	*Evaluating Scour at Bridges, HEC-18*
FHWA	*Stream Stability at Highway Structures, HEC-20*
FHWA	*Urban Drainage Design Manual, HEC-22*
FHWA	*Drainage of Highway Pavements, HEC-12*
FHWA	*Bridge Scour and Stream Instability Countermeasures, HEC-23*
FHWA	*Design of Roadside Channels with Flexible Linings, HEC-15*
FHWA	*Design of Riprap Revetment, HEC-11*
FHWA	*Hydraulic Design of Improved Inlets for Culverts, HEC-13*
FHWA	*Design of Bridge Deck Drainage, HEC-21*
FHWA	*Hydraulic Design of Highways Culverts, HDS-5*
CDOT	*Erosion Control and Stormwater Quality Guide (2015 rev)*
CDOT	*Consultant Helper: Permanent Water Quality Report, 2/21/2014*

12.1 Administrative Requirements

12.1.1 Coordination with Other Agencies and Disciplines

The Contractor shall coordinate all drainage related issues with affected regulatory agencies, where appropriate. The Contractor shall include CDOT in all contacts with appropriate regulatory agencies.

The implementation of the conceptual drainage plan, as described in the REA, WQTR and DDR, is dependent upon agreements between CDOT and third parties. *These agreements are anticipated to be completed prior to the execution of the contract between CDOT and the Contractor.* The agreements will identify existing and proposed drainage facilities that currently receive runoff from C-470 or off-site basins and that will receive runoff from Project improvements or off-site basins (see Section 6, Third Parties). All proposed designs and construction must fully comply with the terms of these agreements.

12.1.2 Permits

The Contractor shall adhere to the requirements of the various environmental and stormwater permits that are necessary for construction and operation of the Project. The Contractor shall follow the requirements of the latest CDOT Stormwater Management Plan (SWMP) template and related specifications. The Contractor shall be responsible for complying with CDOT's MS4 Permit. The Contractor shall be required to obtain all permits, unless otherwise indicated in the Contract Documents. The listing herein is not all-inclusive and it shall be the responsibility of the Contractor to determine all of the permits required to perform the Work. It is the responsibility of the Contractor to comply with the requirements of all permits. The Contractor shall refer to Section 5, Environmental Requirements, for additional requirements. If conflicts exist between requirements of Section 5 and Section 12, the more stringent requirement shall apply.

12.1.2.1 Colorado Discharge Permit System CDPS, Stormwater Construction Permit (CDPS-SCP)

CDOT has the authorization to discharge under the Colorado Discharge Permit System. Implementation of the permit requirements (i.e., SWMP, SWMP Site Map, and SPCC Plan) shall be a first construction item. Construction cannot begin until these items have been accepted by CDOT. CDOT will review the Contractor's stormwater management activities throughout the duration of the Project for verification of compliance with the CDPS-SCP and CDOT's construction section of its MS4 Permit. The Contractor shall comply with CDOT *Standard Specifications,* Sections 101, 107 and 208.

The surface area of erodible earth material exposed at one time by clearing and grubbing and earthwork operations shall not exceed 34 acres as required by Section 208.04(e) of the CDOT *Standard Specifications*.

The Contractor may request permission in writing to exceed the 34 acre maximum. This request must include information on the Contractors plan and the resources that will be utilized to ensure compliance with the requirements of the CDPS-SPC and Section 208 of the CDOT *Standard Specification*s.

Permission to exceed the 34 acre maximum will be given at the CDOT's discretion and may be withdrawn at any time if the Contractor fails to meet the requirements of the CDPS-SPC and Section 208 of the CDOT *Standard Specifications*.

The Contractor shall obtain a CDPS-SCP from the Colorado Department of Public Health and Environment (CDPHE) for construction of the Project prior to construction work commencing. The CDPS-SCP shall be in the Contractor's name. The Contractor shall adhere to all requirements of the CDPS-SCP and the Construction Section of CDOT's MS4 Permit. Non-compliance issues and necessary Best Management Practices (BMP) deficiencies will be noted during the Monthly Inspections by CDOT or the Regional Erosion Control Advisory Team (RECAT) inspections (or the equivalent under a new MS4 permit). CDOT may request an inspection at any time, or issue 105 memos, for non-compliance by the Contractor. The Contractor's Transportation Erosion Control Supervisor (TECS) will maintain a daily stormwater

log. The Contractor shall prevent the discharge of any sediment or pollutants into any storm drains or receiving waters during the life of the CDPS-SCP.

12.1.2.1.1 Storm Water Management Plan (SWMP)

The SWMP work shall include the CDOT SWMP template and a SWMP Site Map that documents the detailed erosion/sediment control BMPs and their locations. For all work within CDOT ROW, the Contractor shall submit a SWMP and SWMP Site Map for Acceptance by CDOT. For all work outside of CDOT ROW, the Contractor shall submit a SWMP and SWMP Site Map for Acceptance by the Local Agency. The Contractor shall fill out the current CDOT SWMP template, including BMP narratives. The SWMP and SWMP Map shall clearly describe/show the relationship between the phases of construction and the implementation and maintenance of the stormwater management controls. Any significant modifications (i.e., change modification orders or minor change revisions) to the CDOT SWMP template shall be submitted to CDOT for Acceptance. The Contractor's TECS shall revise the SWMP Site Map as necessary based on actual construction activities throughout the duration of the CDPS-SCP. All BMPs shall be shown on the SWMP Site Map per the requirements of the CDPS-SCP.

Contractor shall keep onsite at all times, all documents pertaining to the CDPS-SCP in the CDOT Stormwater Management Plan (SWMP) Notebook (provided by CDOT) to maintain compliance with the SCP. Upon permit inactivation, the SWMP Notebook shall be turned over to CDOT and become the property of CDOT.

12.1.2.1.2 Best Management Practices (BMPs)

The Contractor shall install and maintain construction BMPs for the Project in accordance with the CDOT *Erosion Control and Stormwater Quality Guide* and Sections 101, 107, and 208 of the *Standard Specifications*. Construction BMPs for the Project shall include, but are not limited to, those listed in the *Standard Specifications*, as well as, preservation of existing vegetation, surface roughening, tackifier or soil binder, soil retention blankets, temporary clean water diversions, storm drain and basins, protection of trees, hazardous waste and spill containment and saw water disposal, stabilized construction entrances, and pavement sweeping of the affected Project areas. If non-standard CDOT BMPs are proposed, the Contractor shall obtain Approval, add a BMP narrative to the SWMP describing how the BMP is being used, and shall supply the manufacturer details to be placed in the SWMP Notebook. The Contractor shall have a complete supply of all necessary construction BMP Materials on Site at all times in preparation for construction water quality control emergencies.

Where permanent seeding operations are not feasible because of seasonal constraints (e.g., summer and winter months), the Contractor shall have mulch and mulch tackifier applied to disturbed areas to prevent erosion. Slopes shall be roughened at the end of each day. Concrete washout (including "saw water") shall be properly contained and disposed.

The Contractor shall use an extended term erosion Soil Retention Blanket (SRB) or Turf Reinforcement Mat (TRM) on all disturbed slopes or ditch/channel facilities that require stabilization to promote the establishment of vegetation. The Contractor shall use the appropriate SRB (per CDOT Erosion Control and Stormwater Quality Guide, 2015) for areas with disturbed slopes with 3:1 (H:V) gradients or steeper that do not exceed slope gradients of 2:1 (H:V). The SRB must have a 24-month typical functional durability and be able to withstand

a maximum permissible shear stresses as specified in Section 5.5, CDOT *Erosion Control and Storm Water Quality Guide*.

The design of stable ditches and open channels is described in Section12.2.4.1.4, Roadside Ditches, Open Channels and Slope Protection.

Non-structural BMPs may include litter and debris control, street sweeping, and landscaping and vegetative practices.

12.1.2.1.3 Spill Prevention, Control, and Countermeasures Plan (SPCC Plan)

The Contractor shall prepare and submit a SPCC Plan for Acceptance by CDOT in accordance with Section 5, Environmental Requirements. The SPCC Plan will be included in the SWMP Notebook and updated as conditions require.

12.1.2.1.4 Temporary Drainage

The Contractor shall be responsible for temporary drainage of the Project area during construction to provide adequate drainage and minimize hydroplaning and icing problems for each phase or stage of construction. The Contractor shall keep all existing storm drainage systems used for temporary drainage of the Project in operating condition during construction. Prior to the start of construction, the Contractor shall locate and clean all existing drainage systems in accordance with Section 202 of CDOT *Standard Specifications*. Throughout the duration of the permit, the Contractor shall continually protect inlets from sediment and pollutants and, if needed, shall remove any material deposited in the systems. All existing, temporary, and new permanent inlets and outlets shall be identified on the SWMP Site Map and shall follow the requirements of Section 208 of CDOT *Standard Specifications*.

The Contractor shall submit Temporary Drainage Plans to CDOT for Acceptance in accordance with Section 12.4.2.1.

12.1.2.1.5 Erosion Control Management

The Contractor shall assign one or more employee(s) or subcontractor to the Project to serve in the capacity of the Transportation Erosion Control Supervisor (TECS). The TECS shall be a person other than the Superintendent and shall be a person dedicated solely to erosion/sediment control. The TECS shall be experienced in all aspects of construction and have satisfactorily completed the CDOT Transportation Erosion Control Supervisor (TECS) training, per CDOT *Standard Specifications*, Section 208, Erosion Control Supervisor. Certification that this requirement has been met shall be submitted to CDOT at NTP1.

Per Standard Special Specifications, Section 208.03 (c), One TECS shall be required for every 40 acres of disturbed area. When more than one TECS is required, the Contractor shall appoint one of the TECSs to also serve as the SWMP Administrator. The SWMP Administrator is responsible for maintaining the SWMP. Changing the person assigned as the SWMP Administrator after the project starts requires written Approval by CDOT. The name and certification number of the SWMP Administrator shall be recorded on SWMP Plan Section 3.B.

The Contractor's TECS responsibilities shall follow the duties as laid out in *Standard Special Specifications, S*ection 20803 (c), in addition to the following:

1. Direct the removal of sediment, trash, and debris from the construction BMPs and drainage facilities within the affected areas of the Project.
2. Prepare a written report documenting that BMPs are adequate for the Site conditions of the Project and are in good working condition after inspections requiring documentation. The reports shall be kept with the SWMP inspection documentation and submitted to the CDOT Region Water Quality Manager. The appropriate form for this report will be supplied by CDOT. The inspections shall be made during the progress of the Work, during Work suspensions, and for the duration of the CDPS-SCP.
3. Ensure any findings from inspections on CDOT ROW are corrected within 48 hours of the inspection.
4. During the Work, perform inspections according to the required intervals of CDOT's MS4 (at least every 14 days, or immediately after each event that causes stormwater runoff).
5. During Project Work stoppages, inspections shall take place at least once every 30 Days, and within 48 hours after each event that causes surface runoff. After construction is complete, inspections shall take place at least once every 30 Days until final stabilization is achieved and the permit is closed.
6. When Work is occurring in a Local Agency's jurisdiction, conduct inspections according to the required intervals of the Local Agency.
7. Implement the necessary actions to reduce anticipated or presently existing water quality or erosion problems resulting from construction Activities. The criteria for this action shall be based on water quality data derived from any inspections and monitoring operations or by any anticipated conditions (e.g., predicted storms) that could lead to unsuitable water quality situations.

12.1.2.1.6 Inspections

During the Project, multiple inspections by CDOT and the Contractor and their TECS will occur. Inspections shall be on the appropriate CDOT Forms and shall follow the requirements in *Standard Special Specifications,* Section 208.03 (c). Prior to work commencing, an environmental pre-construction conference shall be held with the CDOT's Region Water Quality Pollution Control Manager (WPCM). In addition, once the first phase of BMPs have been installed, the Contractor shall notify CDOT's Region WPCM to inspect the BMPs for proper installation. Work shall not begin until the initial BMP installation inspection has occurred. CDOT's Region Water Quality personnel will inspect the Site on a monthly basis, as well as during any Regional Erosion Control Assessment Team (RECAT) inspections (or their equivalent, if the new MS4 permit is in force). The Region Water Quality personnel may inspect the Project at any time and document any non-compliance issues that need to be resolved immediately by the Contractor. Fines may be assessed to the Contractor with the potential of Project shut downs, depending on the severity of the non-compliance. Prior to Final Acceptance of the Project construction, CDOT's Region WPCM shall be notified to perform a final walkthrough inspection. Notification must occur at least two weeks prior to the anticipated inspection. Any items identified for maintenance, replacement, or removal shall be done immediately or liquidated damages may be incurred upon the Contractor.

The Project Superintendent or TECS shall perform daily inspections of all BMPs to observe, record, and determine the effectiveness of all BMPs and to order their maintenance if needed.

The results of the daily inspections shall be recorded in a daily stormwater log and included in the SWMP Notebook. The Contractor shall cooperate with Local Agencies that may perform their own stormwater inspections on this Project. The Contractor shall notify CDOT of any Local Agency inspections at least 24 hours prior to the inspection.

12.1.2.1.7 Colorado Discharge Permit System, Stormwater Construction Permit Closure

The Contractor shall be responsible for all stormwater permit requirements until the Project has achieved final stabilization (see Book 2, Section 17, Landscaping) and the CDPS-SCP permit can be closed. This includes the maintenance of all BMPs, maintenance of all seeded/landscaped areas, and removal of all BMPs once final stabilization has been achieved and documented. The Contractor shall notify the Region WPCM at least two weeks prior to closure, at which time, the WPCM will decide whether to require an inspection of the entire Project.

12.1.2.2 Municipal Separate Storm Sewer System (MS4)

CDOT and jurisdictions adjacent to the Project including; Jefferson County, Douglas County, HRMD and Lone Tree, each have a MS4 Permit for the storm drain systems that they own and maintain. The Contractor shall be responsible for complying with the terms and conditions of the MS4 Permits that pertain to the Project as appropriate to provide stormwater quality treatment for runoff from each jurisdiction. CDPHE issued a new MS4 permit for CDOT, effective July 28, 2015. The Contractor shall adhere to the conditions of all sections of the permit in effect at the time of construction, except for those sections related to the NDRD Program, described in the following paragraphs. In addition, the Contractor shall be responsible for complying with other commitments and agreements that affect permanent stormwater quality treatment requirements for the Project. Where MS4 permit requirements conflict, the more stringent requirements shall apply.

Permanent stormwater quality treatment requirements, based on regulations, are governed by the following documents:

- The CDPHE memo of May 22, 2014 entitled “CDPS Permit-New Development and Redevelopment Program Description Modification-Conditional Approval”,
- The CDOT NDRD Interim Guidance dated 9/18/2014, as updated 3/10/2015, which defines the Interim NDRD Program as “NDRD Program Modification, as defined by CDPHE in its May 22, 2014 memo", and
- The January 8, 2015 amendment by CDPHE to the 2014 Interim NDRD Program, which redefined requirements for areas to be treated for stormwater runoff,

These documents will be subsequently referred to as the “2014 Interim NDRD Program" or the “2014 NDRD”. The Project shall be considered as a Priority Project in accordance with Section 2, 2014 NDRD. The facilities for Permanent Water Quality Treatment (defined as “Control Measures” by CDPHE in the May 2014 NDRD Program Modification) shall hereby be referred to as "Permanent Water Quality BMPs” (PWQ BMPs).

Due to the complexity of both design requirements for PWQ BMPs, and in-place agreements, the 2014 interim NDRD Program shall remain in effect, even though the new MS4 permit has become effective as of July 28, 2015.

As documented in the REA, WQTR and DDR, and in agreements with third parties, CDOT has committed to providing permanent stormwater quality treatment that exceeds the minimum requirements of the 2014 NDRD. Additional permanent stormwater quality treatment will be provided for runoff from impervious areas within C-470 and outside of C-470. Only treatment of runoff from impervious areas within C-470 can be used to satisfy commitments described in the REA, WQTR and DDR. Treatment of runoff from impervious areas outside of C-470 will be provided based on commitments described in agreements with the third parties (see Section 6, Third Parties).

PWQ BMPs proposed in the REA, WQTR and DDR will provide required water quality treatment through delayed release of stormwater from a Water Quality Capture Volume (WQCV) provided in Extended Detention Basins (EDBs), as described in Book 2, Section 12.2.4.4, Extended Detention Basins.

Approximately, 172% of the minimum stormwater quality treatment required by the 2014 NDRD for C-470 (treatment of runoff from 185.1 impervious acres of C-470) must be provided to satisfy commitments described in the REA, WQTR and DDR for the Ultimate Configuration. The portion of the Ultimate configuration included in the Base Configuration requires that about 182% of the minimum stormwater quality treatment required by the 2014 NDRD for C-470 be provided by the Project. Approximately, 142% of the minimum stormwater quality treatment required by the 2014 NDRD for the runoff from the impervious area of C-470 directly tributary to the South Platte River (treatment of runoff from 28.4 impervious acres of C-470) must be provided to satisfy commitments described in the REA, WQTR and DDR. Treatment provided for runoff from C-470 impervious areas directly tributary to the South Platte River must be accounted for separately, because the South Platte River is classified as impaired for arsenic, which is listed as a roadway related contaminant in the 2014 NDRD. Treatment provided for runoff from C-470 impervious areas directly tributary to the South Platte River can be used to satisfy the commitment to provide 172% (182% for the Base Configuration) of the stormwater quality treatment required by the 2014 NDRD for all of C-470 in the Ultimate Configuration.

The required level of treatment, 172% of the 2014 NDRD for the Ultimate Configuration requirement and 182% of the 2014 NDRD for the Base Configuration requirement, was calculated including pre-project and post-project impervious areas that contribute runoff to existing offsite facilities. Impervious areas contributing to Pond 935S were not included in this calculation and may not be used to satisfy Project commitments for water quality treatment.

Some of the new PWQ BMPs to be constructed with the Project will provide treatment for runoff solely from impervious areas from C-470 (New) and some of the new PWQ BMPs will provide

treatment for runoff from impervious areas within C-470 and outside C-470 (New Shared). Where commitments for water quality treatment of runoff from impervious areas within the Project are satisfied using existing facilities (Existing Shared), by agreement with Local Agencies, no new treatment facilities are required. However, runoff from C-470 must be conveyed to the existing shared facilities in compliance with Project standards and criteria and third party agreements. Each of these categories of PWQ BMPs are listed in Table 12.1-1.

Proposed locations of PWQ BMPs are more accurately described in the DDR. New PWQ BMPs shall be sized to provide treatment for all tributary upstream impervious areas both within C-470 and outside of C-470.

All New CDOT PWQ BMPs will be maintained by CDOT, and designs must meet CDOT's design requirements, as specified in the 2014 NDRD. The designs for these facilities shall be reviewed and Approved by CDOT, including the CDOT Region 1 Maintenance Superintendent, and shall meet specifications for safe maintenance access using existing CDOT maintenance equipment.

TABLE 12.1-1
PERMANENT WATER QUALITY BMPs

New CDOT	New Shared	Existing Shared
Pond 804s	Pond 1072S	Pond 990N
Pond 850N	Pond 1082s	Pond 1018N
Pond 879N	Pond 1120S	Pond 1042S
Pond 890s	Pond 1185S	Pond 1327S
Pond 1126		
Pond 1149s		
Pond 1390N		
Pond 1392S		

All New Shared PWQ BMPs are associated with third party agreements and will be maintained by the third party. The designs for these facilities shall be reviewed and approved by the parties to the agreement, and shall meet local agency specifications for safe maintenance access using existing maintenance equipment.

Additional detail regarding the design of EDBs is provided in Section 12.2.4.4, Extended Detention Basins.

12.1.2.2.1 Illicit Connections or Discharges

The Contractor shall immediately notify CDOT and the appropriate Local Agency of any suspected illicit or improper connections or discharges into any drainage system that are discovered during design or construction of the Project. The Contractor shall contact the CDOT

Illicit Discharge Hotline at 303-512-4426. CDOT and the Local Agencies will be responsible for investigation of the suspected illicit connection and implementing corrective action. The Contractor shall not maintain, reconnect, or otherwise allow discharge of improperly disposed materials into the storm drain system.

12.1.2.2.2 Mitigation Fund Tracking

A portion of the Project funding is being provided by CDOT's NDRD Mitigation Pool. The Contractor shall track Project quantities and costs, within the Permanent Stormwater Management WBS Level IV and V activity, as required to document improvements constructed using these funds. These funds are only for construction of permanent water quality BMPs. Where water quality and flood control functions are included in the same facility, quantities and costs specifically for flood control shall be excluded from the tracking costs. Quantities and costs for *shared* water quality-flood control facilities may use an average of 25% deduction from the aggregate quantity or cost. This percentage is based on the average of cost estimates for water-quality only versus shared water quality-flood control facilities for this Project. Tracking shall show methods used and deductions taken for shared quantities and costs. Payment requests for construction of these facilities shall occur monthly.

Solely for purposes of tracking Mitigation Pool funding use these following categories. Water quality-facilities that are fully funded from the Mitigation Pool are located at: 850N, 879N, 1072S, 1185S and 1392S. Combined water quality-flood control facilities that are partially funded from the Mitigation Pool are located at 804S, 890S, 990N, 1018N, 1042S,1082S, 1120S and 1390N. Costs associated with Pond 990N and 1042S are related to improvement of access roads, which were added to the plan after completion of the Mitigation Pool application. All quantities and costs for these facilities shall be tracked for Mitigation Pool reimbursement. All other facilities are flood control-only, and do not qualify for NDRD Mitigation Pool funding.

12.1.2.3 Construction Dewatering Permit

Contractor shall obtain a Construction Dewatering permit as described in the Section 5, Environmental Requirements.

12.1.2.4 U.S. Army Corps of Engineers (USACE) Section 404 Permit

The Contractor shall obtain 404 permits as described in Section 5, Environmental Requirements. The HS and DDR provide information regarding potential environmental and hydraulic impacts related to floodplains within the Project.

12.1.2.5 Floodplain Regulations

The Contractor will comply with all local, state and federal regulations associated with potential impacts to regulated floodplains. Regulated floodplains include the most recent flood hazard areas delineated on FEMA FIRMs (or DFIRMs) or shown by more recent studies or local floodplain maps. The Contractor shall obtain floodplain development permits (FDP) and map revisions for impacts to floodplains crossing the Project. The Contractor shall obtain Approval for, and provide all technical analysis and supporting documentation, necessary for work in

regulated floodplains associated with Massey Draw, South Platte River, Dad Clark Gulch, Big Dry Creek and Willow Creek as further described in Book 2, Section 12.2.8, Floodplains. Although Lee Gulch does not have a FEMA regulatory floodplain, Contractor shall comply with any local agency review and permitting requirements.

The HS and DDR provide information regarding potential impacts to floodplains and anticipated regulatory processes for obtaining permits and/or obtaining map revisions, as necessary.

12.1.2.6 Senate Bill 212 Requirements

Senate Bill 212, Colorado Revised Statute 37-92-602 (8) (SB 212), contains requirements regarding the design of new stormwater detention and infiltration facilities and notifications regarding the intention to operate new stormwater detention and infiltration facilities.

The Contractor shall design stormwater detention and infiltration facilities to meet Project goals and requirements and in accordance with the requirements of SB 212. Where standards conflict with SB 212 requirements, the more stringent requirements shall apply.

SB 212 also requires that an "entity that owns, operates or has oversight for" new stormwater detention and infiltration facilities shall, prior to operation of the facility, provide notice to all parties on the substitute water supply plan notification email list maintained by the State Engineer. The Contractor shall, on behalf of CDOT and Local Agencies that will own and maintain new facilities, provide the required information for said notifications. The Contractor shall disseminate said notifications for each stormwater detention and/or water quality treatment facility to be owned by CDOT, as required by this statute. The Contractor shall not disseminate said notifications for stormwater detention and/or water quality treatment facilities to be owned by the HRMD, but shall provide the required information to CDOT directly. (Note: Urban Drainage and Flood Control District (UDFCD) has prepared a process for the notification.) The information for facilities to be owned by HRMD shall be provided to CDOT no less than two weeks prior to the schedule required by the statute. The Contractor shall include CDOT as a recipient of the notification(s) sent to the substitute water supply plan notification email list and provide documentation to CDOT that the required notifications have been provided, as required.

12.2 Design Requirements

The Contractor shall design all facilities to comply with the standards and criteria described in Tables 12.0-1 and 12.0-2, as further described herein after, and in all of the Contract Documents.

12.2.1 Drainage Design Software

The following software (most recent versions) may be used in performing drainage design calculations.

1. USEPA, EPA SWMM
2. USACE, HEC-RAS

3. FHWA, HY-8
4. Bentley, InRoads Storm and Sanitary
5. Bentley FlowMaster
6. Bentley CulvertMaster
7. UDFCD, CUHP
8. UDFCD, UDSWMM
9. UDFCD, UD-Sewer
10. UD-Culvert
11. UDFCD, UD-Detention
12. UDFCD, UD-FSD
13. UDFCD, UD-Inlet
14. UDFCD, UD-Rain
15. UDFCD, UD-Rational
16. UDFCD, UD-BMP

All software used must be capable of creating summary tables for both all individual input values and all individual output values (including all hydraulic losses) and summary tables of the accumulated results of the analyses at key locations in the system.

Other proprietary drainage design software and spreadsheets may be used if it is certified by the software developer that it meets the design requirements herein, and with prior Acceptance by CDOT. No software or spreadsheets created by the Contractor may be used without Acceptance by CDOT. Acceptance of alternative software or spreadsheets will require that the Contractor demonstrate that the proposed alternative provides analyses and results not adequately provided by already approved software or spreadsheets and that the results provided by the proposed alternative are of comparable accuracy and reliability as already approved software or spreadsheets. CDOT is under no obligation to consider alternatives to approved software and spreadsheets and may accept or deny the use of proposed alternatives at its sole discretion.

12.2.2 Data Collection

The Contractor shall identify all drainage-related issues utilizing available data, including but not limited to, requirements imposed by local, state, and federal government regulations, and official documents concerning the Project.

The Contractor shall obtain all relevant storm drainage improvement plans, drainage planning studies, and drainage reports for the Project area from CDOT, FEMA and all Local Agencies including; Douglas County, Jefferson County, Lone Tree, HRMD, UDFCD and ditch companies. CDOT has collected numerous documents related to drainage adjacent to the Project that are

available to the Contractor as attachments to the DDR. CDOT makes no representation as to accuracy, completeness, or adequacy of these documents.

The Contractor shall obtain existing and projected future land uses from all Local Agencies, as necessary to design facilities to be compatible with drainage systems, existing or proposed, on adjacent properties.

The Contractor shall perform detailed mapping and surveys, as required, to verify locations of existing drainage features necessary for the proposed drainage design. The Contractor shall verify or identify boundaries, flow patterns, and land uses of drainage basins based on field observations.

The Contractor shall resolve all conflicts between Utilities and proposed drainage improvements in accordance with Section 7, Utility Relocations.

12.2.3 Surface Hydrology

The Contractor shall perform hydrologic analyses for all on-site drainage basins and for all local off-site drainage areas immediately adjacent to the Project that contribute runoff to on-site drainage basins. Local, on-site drainage basins shall include those that contribute to New PWQ BMPs. Local, off-site drainage basins shall include those contributing flow onto the Project where flow rates are not quantified by published documents, and that contribute runoff to New Shared PWQ BMPs. The analyses shall be based on projected future land uses and the Ultimate Configuration.

Design flow rates for cross drains on the Project shall be 100-year flow rates based on available published design flow rates, unless otherwise described herein. Design flow rates for cross drains are published in several sources and summarized in the DDR.

The Contractor shall perform hydrologic analyses for any locations where published design flow rates are not available or where changes in off-site drainage patterns are proposed as a result of the design of the Project.

12.2.3.1 Design Frequencies

For all CDOT-owned facilities, the design storm frequency shall comply with Table 7.2, Table of Design Frequencies, in the CDOT *Drainage Design Manual,* except that the design storm frequency of storm drains on C-470 shall be no less than 10-year.

The design storm frequency for all cross drains shall be the 100-year.

The design storm frequency for all other roadways affected by the Project shall comply with the affected Local Agency's criteria.

12.2.3.2 Precipitation

Precipitation data for all drainage analyses shall be obtained from the most recent drainage manual applicable to the jurisdiction to which Project improvements will discharge runoff. In Jefferson County this document is the *Storm Drainage Design and Technical Criteria Manual*, April 1, 2014. In Douglas County this document is the *Douglas County Storm Drainage Design and Technical Criteria Manual*, July 8, 2008.

12.2.3.3 Hydrologic Methods

The Contractor shall perform all necessary hydrologic analyses required to evaluate and satisfactorily comply with all Project design standards and criteria, except as provided by previously published documents as described in Book 2, Section 12.2.3, Surface Hydrology. The Contractor shall perform the necessary hydrologic analyses using the following methods:

1. Areas less than 90 acres shall be evaluated using the Rational Method as described in the UDFCD *USDCM*. The minimum time of concentration shall be 5 minutes.

2. Areas greater than 90 acres shall be evaluated using the CUHP Unit Hydrograph Procedure and UDSWMM with the standard 2-hour Rainfall Distribution.

The hydrologic analyses shall be based on the Ultimate Configuration for C-470 and shall also include analyses so that the drainage system satisfies all Project design standards and criteria for the Interim Configuration.

12.2.4 Hydraulic Structures

12.2.4.1 Roadways

Roadway component geometric configurations shall be designed to provide adequate drainage and minimize hydroplaning and icing problems. Cross slopes shall be in accordance with the requirements of Book 2, Section 13, Roadways.

12.2.4.1.1 Roadway Profile

Longitudinal grades shall be in accordance with the requirements of the Book 2, Section 13, Roadways. Where minimum profile grades cannot be obtained in sag vertical curves, flanking inlets shall be constructed in the curb and gutter, or adjacent to the solid barrier guardrail, as required in the CDOT *Drainage Design Manual*.

12.2.4.1.2 Allowable Flow Spreads

The Contractor shall design all roadway and ramp storm drain systems including gutters, inlets, inlet spacing, catch basins, laterals, and trunk lines using the design criteria provided in Table 12.2-1.

All other roadways outside of CDOT ROW shall comply with the Local Agency's criteria.

Table 12.2-1

ROADWAY DESIGN STORM AND FLOW SPREAD CRITERIA		
Road Classification	**Design Storm**	**Flow Spread**
C-470 &all associated ramps	5-year	Shoulder
	10-year	Shoulder + 3 ft
	50-year (sump)	Shoulder
	100-year (continuous grade and sump)	Shoulder + 4 ft

12.2.4.1.3 Edge Treatment

In areas where the roadway pavement discharges runoff to Type 7 guardrail or curb, inlets shall be used to collect flow from the curb section. Where storm drain systems convey runoff collected from the roadway to side ditches or channels, the drains shall be piped to the bottom of the slope. Rundowns shall not be used to convey concentrated flows to the bottom of slopes. Erosion protection shall be constructed at the outfalls. See Section 12.2.4.10, Drain Outfalls, for more information.

12.2.4.1.4 Roadside Ditches, Open Channels and Slope Protection

For roadside ditches along all existing and proposed roadways, the design water surface profile shall have a minimum of one foot of freeboard for the 10-year storm frequency peak discharge and shall not exceed edge of pavement for the 100-year storm frequency peak discharge.

All open channels within the Project shall be designed to capture and convey the 100-year design flow. Capacity shall be determined using Manning's Equation.

All roadside ditch inverts shall be set, at least, one foot lower than the intersection of the ditch side slope with the bottom of the roadway pavement section to avoid routine exposure of the pavement section to routine ditch flows. Stabilized subgrade shall not be considered part of the roadway pavement section relative to this requirement.

All proposed roadside ditches, swales or other areas of concentrated flow shall be evaluated to determine the channel hydraulic shear stresses for 10-year design flows. Where hydraulic shear stresses are found to exceed the maximum allowable shear stresses, a TRM or riprap armoring shall be designed and placed to protect against the design shear stresses in the proposed ditch/channel facility. The maximum permissible shear stresses for a TRM Class 3 (CDOT *Standard Special Provision 216*) must meet or exceed the criteria identified in the CDOT *Erosion Control and Stormwater Quality Guide* (2015 rev). Where slopes exceed the maximum allowable gradient of 5% or where the maximum allowable shear stress of 3.1 lbs./sq. ft. is exceeded, embedded riprap armoring shall be designed and placed to protect against the design shear stresses in the proposed ditch/ channel facility.

Flexible channel linings shall be designed in accordance with Federal Highway Administration (FHWA) *HEC-15, Design of Roadside Channels with Flexible Linings*. Riprap

channel lining shall be designed in accordance with FHWA *HEC-11, Design of Riprap Revetment*.

All abandoned concrete diversion structures in roadside ditches and open channels shall be removed, unless otherwise directed by CDOT.

12.2.4.2 Cross Drains

Cross drains shall be defined as pipes or culverts that convey water from one side of C-470 to the other. All cross drains shall be designed for the 100-year frequency peak discharge for the Ultimate Configuration and Interim Configuration with no inundation of the C-470 paved shoulders or adjacent properties.

Hydraulic design of cross drains shall be based on the procedures included in FHWA *HDS No. 5, Hydraulic Design of Highway Culverts*. Hydraulic design data shall be listed on the final Design Plans for each cross drain, including drainage area, peak discharges, allowable headwater elevation, and design headwater elevation.

The minimum allowable pipe size for cross drains shall be 36 inches in diameter and the pipe or culvert shall be reinforced concrete. Flared end sections, with toe walls, or headwalls with beveled edges, and wingwalls, shall be provided for all cross drain ends, regardless of size. Concrete aprons, with a toe-wall shall be installed at the ends of box culverts, with the necessary scour protection. To reduce culvert sizes, improved inlets may be utilized. Improved inlets shall be designed based on FHWA HEC-13, *Hydraulic Design of Improved Inlets for Culverts*.

All cross drain pipe shall be reinforced concrete with gasketed joints, per CDOT standards and specifications.

Allowable headwater elevation for the 100-year frequency peak discharge shall be designed as described in Chapter 9.2.2 of the CDOT *Drainage Design Manual*. In addition, allowable headwater elevation shall be limited by the minimum of the following:

1. Non-damaging to upstream or adjacent property.
2. Below outside edge of roadway shoulder elevation.
3. Headwater/Depth ratio requirements shall be as shown in the CDOT *Drainage Design Manual, Table 9.3*.
4. No overflow to another drainage basin is allowed.

The use of sag pipes or inverted siphons shall not be allowed.

Cross drains shall be continuous and straight. Bends or turns will not be permitted.

Cross drains that are connected directly to off-site existing drainage systems shall have a manhole constructed inside and adjacent to CDOT ROW to join the CDOT cross drain to the existing drainage system. Manholes shall be constructed of the appropriate size and type, according to the CDOT *Drainage Design Manual*.

All stormwater runoff, either from off-site or on-site areas, shall drain freely to an existing cross drainage or storm drain system.

12.2.4.3 Storm Drains

Storm drains shall be defined as a network of pipes that connect inlets, manholes and other drainage features to an outfall. Cross drains connected to the storm drainage system are considered part of the storm drain system for the purpose of determining the hydraulic performance of storm drains. Runoff, from within the limits of the Project, and draining onto the Project, shall be collected and conveyed in a drainage system designed for the design frequencies included herein. The drainage system shall be designed to not worsen the existing conditions for properties outside the CDOT ROW or Easement. Ponding will not be permitted within the Project, except at specifically designed stormwater detention & PWQ BMP facilities.

Hydraulic analyses and plans for storm drains that are connected to existing storm drain systems upstream or downstream of the Project must be coordinated with affected Local Agencies. The hydraulic analyses shall identify the impacts to the existing storm drain systems caused by the connections and proposed combined peak design discharges for the overall systems. The Contractor shall obtain Acceptance of the proposed design by Local Agencies affected by connections to their storm drain systems and for runoff leaving the Project.

The minimum allowable pipe diameters for storm drain systems are shown in Table 12.2-2.

TABLE 12.2-2
MINIMUM ALLOWABLE PIPE DIAMETER

Application	Minimum Diameter (inches)
Side Drain	18
Median Drain	18
Storm Drain Trunk Line	18
Connections: - Median drain to cross drain - Curb Inlet to trunk line	 15 15

All storm drain pipes shall be reinforced concrete with gasketed joints, per CDOT *Standards and Specifications*.

The use of sag pipes or inverted siphons will not be allowed.

Storm drains shall not decrease in size in the downstream direction. From upstream to downstream, pipe diameters shall remain constant or increase. All bends and turns shall occur within a manhole or inlet.

The maximum allowable pipe diameter within Mechanically Stabilized Earth (MSE) strap zones shall be 30 inches outside diameter.

12.2.4.3.1 Hydraulic Design of Storm Drains

Storm drain system design shall be performed using hydraulic gradient analysis to account for all friction and minor losses. Friction losses shall be calculated using Manning's Equation. Minor losses at junctions, manholes, bends, and other appurtenances shall be calculated based on design procedures in the FHWA *HEC-22, Urban Drainage Design Manual*.

Storm drains under C-470 shall be designed with the hydraulic grade line (HGL) at or below the crown of pipe for the 10-year frequency peak discharge. The HGL shall be 1 foot below pavement and inlet grates where the pipe is required to convey the 100-year frequency peak discharge. Local Agency criteria shall be followed for storm drain system design outside of CDOT ROW. The hydraulic gradient for the minor (10-year) and major (100-year) design peak discharges shall be plotted for all storm drains in each storm drain profile.

The flow velocity of storm drains shall not be less than 3 feet per second for the 10-year frequency peak discharge and shall not be greater than 22 feet per second for the 100-year frequency peak discharge.

12.2.4.3.2 Storm Drain Alignment and Profile

Storm drain alignments shall be straight between structures. Profiles of all storm drains shall be straight grades between structures.

The Contractor shall comply with Local Agency criteria for storm drains outside CDOT ROW.

12.2.4.3.3 Inlets

Inlets are required to meet the design criteria specified in Section 12.2.4.1, Roadways. In addition, there are a number of locations where inlets may be necessary without regard to contributing drainage area. These locations should be marked on the plans prior to any computations regarding discharge, water spread, inlet capacity, or bypass. Examples of such locations are as follows:

1. Sag points in the gutter grade
2. Upstream of median breaks and entrance/exit ramp gores and street intersections
3. Immediately upstream and downstream of bridges
4. 10 feet upstream of cross slope reversals
5. On side streets at intersections
6. At the end of ditches or channels in cut sections
7. Behind retaining walls, curbs, shoulders or sidewalks to drain low areas
8. Where necessary to collect snow melt

Inlets shall not be located in a path where pedestrians are likely to walk.

CDOT *M&S Standard Plans* inlets shall be used within CDOT ROW. Type C and Type D inlets will not be allowed within the roadway pavement limits. In the event a CDOT standard inlet cannot be used and the inlet is located within the pavement limits, the inlet shall be designed for HL-93 or interstate alternate live loading and shall have traffic rated grates. When outside the roadway pavement limits, Type C and D inlets may be utilized.

Pedestrian-safe grates shall be used in pedestrian areas and bicycle-safe grates used in bicycle areas.

Concrete aprons shall be installed on all area inlets per the CDOT *M&S Standard Plans*.

Inlet hydraulic efficiency and spacing shall be determined based on design procedures in the FHWA *HEC-22, Urban Drainage Design Manual*. 100 percent of the routed bypass flow shall be added to the flow at the next downstream inlet.

For a continuous storm drain system, maximum inlet spacing shall be designed based on allowable flow spread in the roadway, or manhole spacing criteria, whichever is less.

The sag vertical curve or sump area on a roadway requires inlets at the lowest point and flanking inlets on each side of the lowest inlet to provide relief from debris clogging. All sumps shall be designed in accordance with the criteria in Table 12.2-1. The flanking inlets shall be located such that the design criteria for ponding are met, even if the sump inlet is completely clogged

Inlets are required 10 feet upstream of the point where the highway cross slope begins to super-elevate toward the opposite side to prevent pavement cross flow.

Slotted drains or trench drains will not be allowed in the traveled way or transverse to traffic flow on C-470.

The use of scuppers or drainage slots in roadway and median barriers as a drainage element will not be allowed. Curb cuts or slotted barrier shall not be allowed for bridge deck drains.

Access holes for inlets, catch basins, and manholes shall not be located in travel lanes of the roadway.

Inlets shall be designed using the clogging factors included in the CDOT *Drainage Design Manual*. The clogging factor may be reduced for multiple-unit inlets as recommended in the UDFCD *USDCM*.

12.2.4.3.4 Maintenance Access Structures

Maintenance access structures shall be incorporated into the storm drain system to provide access for inspection, cleaning, and other maintenance activities. Maintenance access shall be constructed at all junctions, changes in pipe size, drops, and grade changes. Maintenance access shall be provided at any change in horizontal alignment greater than 2 degrees. Maintenance access shall not be located in travel lanes of C-470 or travel lanes of I-25 ramps,

including travel lanes in the Ultimate Configuration. Inlets should be used for maintenance access where permitted by pipe sizes according to the CDOT DDM.

A lateral that is less than half the size (inside diameter) of the trunkline, and no more than 75 feet long may be connected to the trunkline with a prefabricated pipe wye or tee connection. Larger laterals shall be connected to the trunkline with a manhole.

The spacing of maintenance access structures shall be in accordance with the criteria identified in the CDOT *Drainage Design Manual*. The spacing of manholes outside of CDOT ROW shall be in accordance with Local Agency criteria. For storm drain diameters 60-inch or greater, manholes shall be located considering site conditions that provide for staging of large-scale maintenance activities.

Manhole and junction structure floors shall be shaped to fit the pipe inverts to minimize hydraulic losses within the structure.

Manholes, junction structures, and vaults in roadside areas shall be designed to extend a maximum of 2-inches above the finished grade all around the structure.

12.2.4.4 Extended Detention Basins (EDBs)

The Contractor shall collect surface runoff from drainage basins within and outside of the Project and convey the runoff to an EDB in accordance with the goals and plan described in the REA, WQTR and DDR.

When not anticipated by the DDR, the Contractor shall identify all base flows tributary to the ponds and provide means for these flows to circumvent the EDB. Groundwater seepage, off-site, landscape irrigation, or other type of flow shall not pass through the forebay, trickle channel or micro-pool, except as anticipated by the DDR. EDBs shall be designed in accordance with the *USDCM*, other applicable standards and in compliance with this Section of Book 2.

Groundwater elevations shall be determined by the Contractor at all EDB locations and submitted to CDOT for Review. Observation holes shall be drilled to a depth of, at least, 15 feet to determine the presence of groundwater. If groundwater is encountered within one-foot of the lowest elevation of the bottom of the EDB, measures shall be taken (e.g., perimeter underdrain system or impermeable line) to prevent groundwater seepage or a base flow into the pond.

The REA, WQTR and DDR, included in the Reference Documents, provide information regarding drainage patterns and concepts and proposed locations for flood detention and permanent water quality facilities that are proposed for implementation. The conclusions, recommendations, and design included in these documents shall be used as a starting point to plan and design a functioning flood detention and permanent water quality improvement system to achieve Project goals. The recommendations included in these documents describe the type and location of EDBs proposed to be implemented. The recommendation for providing PWQ BMPs is by implementation of WQCVs within EDBs.

However, it is anticipated that more accurate data and more detailed and precise analyses, to be completed by the Contractor, may result in modifications to the proposed plan that better implement Project goals and standards. Proposals by the Contractor to modify elements of the proposed plan must provide, at least, an equivalent level of performance as the proposed plan and also ensure that Project goals and commitments are achieved.

All but three proposed EDBs are to provide both flood detention and permanent water quality treatment. One proposed EDB (Pond 1126N) is to provide only flood detention and two proposed EDBs (Pond 879N and 1185S) are to provide only permanent water quality treatment. All but four of the proposed EDBs receive runoff only from basins within C-470. Ponds 1072s, 1082S, 1120S and 1185S receive runoff from C-470 and from off-site basins.

All EDBs shall have a concrete forebay, a concrete trickle channel, a reinforced concrete outlet control structure with a micro-pool and a trash rack, as detailed in Figures OS-4, OS-5, OS-6, OS-7 and OS-8 of the USDCM, and a 100-year emergency spillway. All design calculations, geometry and details shall conform to the *USDCM* and shall be provided to CDOT for Approval.

All EDBs shall be designed with the following features:

1. EDB slopes and bottoms shall be protected from erosion from inflows and circulation within the basin.
2. Typical side slopes shall be no steeper than 4:1 (H:V). Side slopes steeper than 4:1 (H:V) will not be Accepted by CDOT, unless steeper slope are essential to complying with Project goals and Approved by CDOT.
3. Slopes shall be planted with a native seed grass mix that minimizes maintenance requirements and is accepted by the CDOT and Local Agency Landscape Architects.
4. Concrete trickle channels to convey nuisance flows, shall be provided from each inflow point to the outlet control structure, merging into a single channel upstream of the outlet control structure. The concrete trickle channel must have a bottom width sufficient for CDOT or Local Agency equipment to provide maintenance, a minimum of 6 feet, and a 6" "mountable" curb. The concrete trickle channel must have a minimum slope of 0.5%.
5. The outlet control structure shall include a debris rack with a total opening size at least twice the size of the low-level outlet. Access to the outlet control structure shall include a concrete ramp at no steeper than a 10% slope to a concrete pad located in the bottom of the micro-pool, at least, 12' x 12' in surface area. The outlet structure shall be embedded into the EDB embankment grading.
6. Forebays shall have concrete bottoms to facilitate maintenance.
7. The bottom of the EDB shall have a minimum slope of 2% from the edge of the trickle channel to the side slopes.
8. The elevation of the emergency spillway or overflow structure shall be at or above the elevation of the routed100-year design water surface or at the elevation of the WQCV storage where flood detention is not required. The emergency spillway or overflow structure shall have the capacity to convey the 100-year peak inflow. Embankments shall provide a minimum of one foot of freeboard above the 100-year overtopping water surface elevation through the emergency spillway.
9. An all-weather maintenance vehicle access shall be provided to the EDB forebay, pond bottom and outlet structures. The structure and surface of the access will be as

specified by CDOT for facilities that will be maintained by CDOT and as specified by the Local Agency for facilities that will be maintained by a third party. The access road shall allow maintenance vehicles to enter and leave the facility moving forward, either by a continuous route through the facility or by a turnaround. Turnarounds shall be adequate for maintenance equipment vehicles, such as pickup trucks, front-end loaders and dump trucks, to enter and leave the facility moving forward. Turnarounds shall have a minimum inside radius of 10 feet and a minimum outside radius of 25 feet. Required EDB maintenance and operation appurtenances and their design requirements are described in *USDCM.*

Where an EDB is proposed to be shared by a third party the Contractor shall not commence work at that location until an agreement between CDOT and the third party, regarding the proposed shared use of the EDB, has been executed.

12.2.4.4.1 Flood Detention in EDBs

Flood detention facilities, with or without water quality treatment, shall be designed to release no more than the pre-project 100-year peak flows from C-470 basins, except at major drainageways, as indicated in the DDR. The pre-project 100-year peak release rates shall be determined at the location of each of the proposed points of discharge. The design release rate for flood detention EDBs (100-year pre-project peak flow rates) must be reduced to compensate for post-project C-470 peak flows that are not detained, but will be released into the same off-site system as the proposed EDB. This is required so that post-project peak flows into off-site systems do not exceed pre-project peak flows.

Where an EDB provides flood detention for off-site basins the design 100-year peak release rates for off-site basins shall be no more than the maximum allowable, undeveloped, release rates, as defined in the *USDCM*.

Where an EDB provides flood detention for runoff from both C-470 basins and offsite basins, the design peak release rates shall be no more than the sum of the design 100-year peak release rate for C-470 basins (including any compensating reductions) and the maximum allowable, undeveloped peak release rates for offsite basins. The design release rates shall be determined at the location of the point of discharge for the proposed EDB.

All EDBs that provide flood detention shall be designed as “full-spectrum” facilities with an Excess Urban Runoff Volume (EURV), according to the *USDCM, Volume 3*. Where water quality treatment is also provided, the total storage volume shall be the sum of the 100-year detention storage volume and the WQCV. Ponds that provide only flood detention, such as Pond 1126N, shall be designed as full-spectrum facilities with the total volume equal to the required flood detention volume, including the EURV, without the addition of the WQCV.

Existing, unintended, or incidental, detention storage volumes at the entrance to existing culverts or storm sewer systems shall not be considered to reduce peak discharges downstream.

12.2.4.4.2 Permanent Water Quality BMP in EDBs

Permanent Water Quality BMPs shall be provided by WQCVs within EDBs. WQCVs shall be sized to treat runoff from all upstream areas that are tributary to the EDB. The WQCV shall be released over a minimum 40-hour drain time and a maximum 72 hour drain time (per state law). The required volumes for WQCVs shall be determined according to the procedures described in the *USCDM, Volume 3.*

Runoff from off-site areas outside CDOT ROW or easement areas shall be kept separate from the on-site pavement runoff and shall not be introduced into a Project PWQ BMP, except as described in the WQTR and the DDR. In the event offsite runoff, not identified in the WQTR or the DDR, cannot be separated from a Project PWQ BMP, the PWQ BMP shall be designed to provide a WQCV for the entire area tributary to the PWQ BMP.

12.2.4.5 Alternative Permanent Water Quality BMPs

WQCVs within EDBs are the proposed PWQ BMP for the Project, however, the Contractor may propose alternatives to the proposed PWQ BMPs. CDOT is under no obligation to evaluate alternatives to the proposed PWQ BMPs and may approve or deny the use of alternative PWQ BMPs, at its sole discretion. Any alternatives to EDBs that are proposed at facilities where a third party will accept maintenance responsibility for the PWQ BMP must be approved by the parties to the agreement.

12.2.4.6 Off-site EDBs

Where the DDR identifies existing shared, offsite facilities that will provide flood detention and/or water quality treatment for C-470 runoff, and where agreements with third parties have been executed to accept C-470 runoff, the Contractor shall design and construct the infrastructure required to collect and convey C-470 runoff to the off-site facilities in compliance with Project requirements.

12.2.4.7 Off-site Drainage Systems

Where the DDR indicates that post-project peak flows will be discharged off-site without detention, or compensating flow reductions from adjacent EDBs, the Contractor shall assess the impacts of the increase in peak flows on the downstream system and provide a report to CDOT for review and Approval. The report shall provide information regarding the source and amount of flows discharged off-site and the characteristics of the off-site system receiving the increase in peak flow. The report shall include options for mitigating the increase in peak flows to the off-site system. The report shall also include a record of communications with the owner of the off-site system and their stated position on how to address potential impacts due to the increase in peak flows.

The Contractor shall take immediate temporary action to mitigate potential impacts due to the increased peak flows while awaiting Approval for proposal to provide permanent mitigation of potential impacts.

The Contractor shall mitigate the increase in anticipated peak flow rates, if necessary, based on the Local Agency direction and as Approved by CDOT.

12.2.4.8 Bridge Deck Drainage

Bridge deck drainage systems shall be designed in accordance with the FHWA *HEC-21*, *Bridge Deck Drainage Systems*. Bridge deck drainage systems are required for Highway Bridges when flow spread limits are exceeded, and to limit flow across expansion joints to less than 1.0 cubic foot per second (cfs) for the 10-year frequency peak discharge. Gutter flow at both ends of bridges shall be intercepted. Stormwater flowing toward the bridge shall be intercepted prior to the approach slab. Stormwater flowing away from the bridge shall be intercepted prior to leaving the approach slab. This stormwater shall be directed to an appropriate outfall.

All bridge deck drain inlets shall be grated. The bridge deck drainage system shall be compatible with the structural reinforcement, components, and aesthetics of the bridge. Outfalls shall be positioned to avoid corrosion of structural members, and splash on vehicular traffic and pedestrian areas below the bridge. Adequate erosion protection shall be constructed at all outfalls. Downspouts for bridge drains shall be minimum 10-inch diameter hot-dipped galvanized steel pipe, and shall meet the requirements of ASTM A53, Grade B, and Standard Weight Schedule 40. See Book 2, Section 15.2.3.4.12 for more information on Bridge Deck Drainage.

12.2.4.9 Stormwater Pumping Stations

The use of stormwater pumping stations shall not be permitted.

12.2.4.10 Drain Outfalls

Cross drain and storm drain outfalls shall be designed such that the outlet elevation is as close as possible to the receiving drainageway flowline to prevent erosion or with an appropriate vertical separation as recommended in design manuals. Outfalls shall be oriented in a downstream direction. Permanent erosion protection shall be provided at all outfalls and along the drainage flowlines where needed. Energy dissipaters shall be designed in accordance with the FHWA *HEC-14 Hydraulic Design of Energy Dissipaters for Culverts and Channels*, or UDFCD *USDCM,* Low Tailwater basins.

Grouted boulder rundowns must extend down to bedrock or to five (5) feet below the future bottom of channel in the receiving water, whichever is less.

Storm drain outfalls shall be evaluated for the effects of tailwater in the receiving major drainageway for the potential of water in the drainageway back flowing through the storm drain system resulting in flooding on state highways or local streets. Flap gates on storm drain outfalls shall be installed if backflow will result in flooding of state highways or local streets, or if required by Local Agencies. The design frequency of the tailwater elevation on the receiving drainageway shall be based on the comparison of design discharge frequencies for coincidental occurrence included in the FHWA *HEC-22, Urban Drainage Design Manual*.

12.2.5 Scour and Erosion Control

Existing scour, rill or channel erosion, slope failures and areas with poor vegetative cover, within the Project limits, shall be identified and corrected by the Contractor.

Bridges over drainageways shall be designed in accordance with the CDOT *Drainage Design Manual* and the CDOT *Bridge Design Manual*. Scour analyses shall be completed for all existing and proposed bridges based on the procedures in the FHWA *HEC-18, Scour at Bridges*, and *HEC-20, Stream Stability at Highway Structures*. Scour countermeasures shall be designed in accordance with the FHWA *HEC-23, Bridge Scour and Stream Instability Countermeasures Experience, Selection, and Design Guidance Third Edition*.

The following minimum criteria apply to riprap layer thickness:

1. Thickness shall not be less than the spherical diameter of the D100 stone or less than 2.0 times the spherical diameter of the D50 stone, whichever results in the greater thickness.
2. Thickness shall not be less than 12 inches for practical placement.
3. The thickness determined by either Criteria 1 or 2 (above) shall be increased by 50 percent where the riprap is placed underwater to provide for uncertainties associated with this type of placement.
4. Stones greater than the D100 spherical diameter shall not be used.

Geotextile (Erosion Control Class 1) shall be used under all riprap per CDOT *M & S Standards*.

12.2.6 Sub-Drainage Systems

Sub-drainage systems (e.g., underdrains) shall be designed in accordance with the CDOT *Drainage Design Manual*. Sub-drainage systems may be discharged to the stormwater system in compliance with regulations for groundwater discharge and control of water quality.

Groundwater may be encountered during construction of this Project. If groundwater is day-lighted to the ground surface via storm drains (point source), a Subterranean Permit from CDPHE will be required. Upon completion of the Project, the permit shall be transferred to CDOT. The Contractor shall be responsible for obtaining the permit. Refer to subsurface analysis in Book 2, Section 10, Geotechnical, Roadway Pavements, and Structure Foundations.

If underdrains are found to exist in certain locations, Contractor shall preserve the capacities and functionality of all existing groundwater drains encountered during construction, or replace drains if impacted by construction. Geotechnical investigations conducted for the Project are provided in the Reference Documents.

If the Contractor encounters wells or springs within the project limits, the Contractor shall protect the flow quantity, water quality, access, and availability of the wells and springs during and after construction.

12.2.7 Irrigation Facilities

All irrigation ditches, canals and laterals crossing the Project shall be protected and preserved in-place and the Contractor shall insure that all facilities are maintained so that normal ditch

operations are uninterrupted. The Contractor shall coordinate with the appropriate ditch companies to identify and mitigate any potential disturbance to the irrigation facilities or operations.

The Contractor shall limit stormwater discharges to irrigation ditches to be equal to or less than pre-project discharges.

See Section 12.2.9 for information regarding issues related to ditch facilities potentially affected by the Project.

12.2.8 Floodplains

The Project potentially impacts FEMA or locally regulated floodplains associated with at least 5 drainageways: Massey Draw, South Platte River, Dad Clark Gulch, Big Dry Creek and Willow Creek. The Lee Gulch floodplain is not shown on FEMA maps, but is recognized on a local agency's map. The floodplains and the anticipated regulatory requirements are discussed in more detail in the HS and the DDR. The Contractor shall comply with all local and federal regulations associated with proposed modifications to regulated floodplains. This will require coordination with Local Agencies and complying with their permit application and submittal requirements and receiving Approval of required floodplain map revisions.

The Contractor shall obtain Floodplain Development Permits, or other similar permits, from the appropriate Local Agencies for any Work associated with the project that is within or will impact regulated floodplains prior to any grading and/or construction within the limits of the regulated floodplains.

Where required by local and/or FEMA regulations the Contractor shall obtain a Conditional Letter of Map Revision (CLOMR) prior to commencing work within regulated floodplains and, upon completion of construction in the floodplains, the Contractor shall obtain a Letter of Map Revision (LOMR) from FEMA to revise the FEMA Flood Insurance Rate Maps (FIRM) to reflect the completed project condition. As a Cooperating Technical Partner, with FEMA, the UDFCD is the Local Agency that will review and recommend approval or denial of proposed map revisions to FEMA. However, each Local Agency affected, or potentially affected, by proposed changes to a regulatory floodplain must be notified and approve proposed changes. The Contractor shall provide all additional mapping and surveying and analyses required to document proposed and constructed changes to the regulated floodplains. The Contractor shall be responsible for all FEMA and Local Agency fees associated with permit applications and requests for all required FEMA or Local Agency map revisions.

Floodplain Administration Contacts:

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12.2.9 Area Specific Drainage Requirements and/or Information

12.2.9.1 Chatfield State Park and Chatfield Dam and Reservoir

Between, approximately, Wadsworth Boulevard and Santa Fe Drive C-470 is located within an easement on federally owned land on which the Chatfield State Park and the Chatfield Dam and Reservoir are located. The Contractor must design the drainage system within this easement so that the post-project peak flow rates do not exceed pre-project peak flow rates at any point of discharge, except directly to the South Platte River as indicated in the DDR. The project must not interfere with the operation of the reservoir outlet or spillway. The Contractor shall contain construction activity and improvements within the C-470 easement. The Contractor shall be

responsible for all coordination with the USACE, and shall provide designs for their review and acceptance.

USACE Contact:

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12.2.9.2 Chatfield Dam and Reservoir Storage Preservation

The operational storage of the Chatfield Reservoir extends up to an elevation of 5,500.0 feet. Any project materials encroachment, below 5,500.0 feet, into reservoir storage, shall be quantified by the Contractor and an equivalent, or greater, volume of material must be removed by the Contractor, below elevation 5,500.0 feet, at an approved USACE location, so that there is no net loss of reservoir storage.

The Contractor shall be fully responsible to obtain CDOT Approval and USACE approval of any impacts and mitigation to the reservoir storage.

12.2.9.3 South Platte River Bridges and Mary Carter Greenway Trail

The Project includes the replacement of two bridges over the South Platte River with wider and longer bridges. The Mary Carter Greenway Trail crosses under C-470, at the South Platte River, adjacent to the westerly abutment of the existing bridges. The Project includes the relocation of the trail along the westerly abutment of the new bridges to improve trail design characteristics, such as sight-distances and clearances. The relocation will also provide a wildlife crossing. During development of the design of the new bridges and trail relocation, the Contractor shall coordinate with the South Suburban Parks and Recreation District (SSPRD), the Colorado Parks and Wildlife Department (CPW), the USACE and CDOT. The trail design shall comply with trail clearances, sight distances, and maximum grades as required by SSPRD. The trail design shall be coordinated with the bridge design and USACE requirements for maintaining the hydraulic characteristics of the South Platte River.

The Contractor shall contain construction for the relocated trail within the C-470 easement, as described in Section 12.2.9.1. The west bank of the river must remain at its current location and elevation, or higher, so that the frequency of flooding on the trail is not increased. The wildlife crossing is proposed to be located between the trail and the top of the left (western) river bank.

The trail relocation shall be designed so that runoff from the trail will drain freely into the South Platte River.

The Contractor shall coordinate the design of the bridge and trail with revisions to floodplain maps and allow for the review and approval process for any required permit applications and/or map revisions in the Project schedule.

Due to operation of the Chatfield Dam and Reservoir outlet works, the 100-year and 500-year design flows have been determined to be 5,000 cfs, according to the Chatfield Reservoir Storage Reallocation Study, USACE, July, 2013. The Contractor shall use these flow rates for the design of trail and bridge improvements and for revisions to floodplain maps.

The Contractor shall construct the proposed trail relocation, affected bridge structures and improvements within the South Platte River floodplain only after Approval by local agencies, FEMA, SSPRD, CPW, USACE and CDOT.

12.2.9.4 Denver Water Department Easements and Potential Water Line Conflicts

At three locations within the Project, portions of EDBs, and/or water ponding behind proposed EDB embankments, as shown in the DDR, will encroach onto Denver Water Department (DWD) easements and be in proximity to DWD water lines. CDOT will be acquiring permanent easements from HRMD for these ponds, but has not secured approval for encroachments onto DWD easements or for acceptance of the pond designs. The three locations are Pond 1072S, Pond 1082S and Pond 1185S, as identified in the DDR.

- **Pond 1072S** - At Pond 1072S, located at the southeast corner of the intersection of C-470 with S. Broadway, a DWD water line traverses land owned by the HRMD and also crosses into C-470 ROW. The water line is located within a 60 foot easement and along the lower portion of a local drainageway that leads to an existing storm drain entrance, adjacent to the eastbound on-ramp to C-470. The water line is frequently exposed to stormwater runoff. The proposed pond storage volume is proposed to be created by construction of an outlet structure that is proposed to be located near the end of the existing storm drain entrance. The proposed outlet structure is expected to be in close proximity to the water line and may be, at least partially, located within the DWD easement.
- **Pond 1082S** - At Pond 1082S, located about 1,000 feet east of S. Broadway, a DWD water line (which appears to be the same water line as the one at Pond 1072S) crosses the existing drainageway that leads to Pond 1082S and also crosses the southerly embankment of proposed Pond 1082S. The water line is located within a 60 foot DWD easement on land owned by HRMD. No excavation required to create the storage volume for Pond 1082S is proposed to be over the water line. However, the southerly end of the proposed pond embankment is proposed to encroach into the water line easement and may increase the cover over the water line by 2 to 3 feet.

- **Pond 1185S** - At Pond 1185S, located about 1,600 feet west of S. Colorado Boulevard, a DWD water line traverses C-470 ROW where a large portion of the proposed pond is located. However, it will probably be necessary to construct a portion of the pond outside of CDOT ROW within the adjacent 50 foot DWD easement on land owned by the HRMD. The proposed pond outlet structure will be in close proximity to the DWD water line.

CDOT and HRMD have agreed, in concept, to build and maintain these and other ponds as described in the DDR. It is anticipated that CDOT and HRMD will execute an agreement that will make HRMD responsible for long-term maintenance of the pond facilities at each of these locations. It is anticipated that an agreement with HRMD will be completed prior to execution of the Contract between CDOT and the Contractor.

For each of the locations described above, the Contractor shall coordinate with the DWD, HRMD and CDOT and provide proposed design information so that the DWD can evaluate the potential impact of the proposed ponds on the water line and easements. The Contractor shall design the ponds to comply with DWD and HRMD requirements and in compliance with the proposed designs in the DDR. CDOT Acceptance of the pond designs will be required prior to construction.

The design shall comply with DWD standards and specifications for construction in proximity to DWD water lines.

12.2.9.5 Cross Culverts at Stations 993+70 and 996+70

The culvert located at about Station 993+70, and about 1,300 feet west of Lucent Boulevard, has a middle section that is 54” CMP with each end connected to 54” RCP that extends upstream and downstream. The RCP at the downstream end of the CMP is connected to a junction structure at about centerline Station 994+30. From the junction structure the system continues to Pond 990N (Pond PA 84 West).

The culvert located at about Station 996+60, and about 860 feet west of Lucent Boulevard, is 2-36” CMPs that drain the gore area between the eastbound travel lanes the eastbound off-ramp and is connected to a 54” RCP at its downstream end. The 54” RCP is connected to the same junction structure as cross drain 993+70, at about Station 994+30.

The Contractor shall evaluate the physical characteristics and hydraulics of the existing drainage system and replace the existing cross drains with appropriately designed cross drain to comply with Project standards and criteria. The design flows for these cross drains are provided in the DDR. The new cross drains shall extend from the upstream drainageways, where each of their existing cross drains begin, to the existing junction structure at about Station 994+30. The existing junction structure that connects the two existing cross drains to the downstream existing pipe shall also be replaced.

12.2.9.6 Cross Culvert at Station 1019+00

The culverts located at about Station 1019+00, and about 1,300 feet east of Lucent Boulevard, includes two culverts under C-470. After a 78" CMP was constructed, a 78" RCP was bored and jacked parallel to it. A concrete entrance transition structure was constructed to reduce entrance losses and to join the upstream ends of the culverts. At the downstream end, the 78" CMP was extended to a concrete junction structure where flows from the two culverts are merged. The concrete junction structure is connected to a 108" RCP that carries flows to Pond 1018N (Pond PA 84East).

The Contractor shall evaluate the physical characteristics and hydraulics of the existing drainage system and replace the existing cross drain with appropriately sized structure(s) to comply with Project standards and criteria. The design flow for the cross drain is provided in the DDR. The cross drain shall be replaced, including the existing upstream enhanced inlet structure, to the junction structure connected to the existing 108" RCP. The existing junction structure connected to the existing 108" RCP shall be replaced to accommodate the new cross drain.

12.2.9.7 Cross Culvert at 1332+00

This existing 84" CMP cross drain located, approximately, at Station 1332+00 and about 100 feet east of Acres Green Drive, connects to an inlet box at its upstream end and continues beyond C-470 ROW downstream. North of the C-470 ROW the cross drain continues under a local roadway and into an underground detention facility, located under the Fred Emich Pontiac parking lot.

The Contractor shall evaluate the physical hydraulic characteristics of the existing drainage system and construct a new cross drain that is hydraulically equivalent to the existing cross drain. The hydraulic evaluation must include the effect of the downstream tailwater due to the underground detention storage facility. The hydraulic capacity of the existing cross drain shall be determined by the peak flow rate that can be conveyed to the downstream detention facility before the hydraulic grade line elevation at the upstream end exceeds the ground elevation adjacent to the existing upstream inlet box, causing flow to overtop onto Acres Green Drive.

The new cross drain must extend from the upstream inlet box to the northern C-470 ROW boundary. The upstream inlet box shall be replaced to collect runoff from the upstream drainage basin and provide a junction for the existing storm drain pipes that discharge into the existing inlet box. A new junction structure shall be constructed where the downstream end of the new cross drain joins the existing downstream pipe. The downstream junction structure shall be located within and adjacent to the northern C-470 ROW boundary.

12.2.9.8 Cross Culvert at 1353+20

The cross drain located at about Station 1353+20 is a 60" CMP. This culvert collects runoff from the existing C-470 roadway and upstream development. This culvert extends from an

"informal" detention area (Pond H), south of C-470, northeasterly across C-470, under a local roadway to the downstream end of the Willow Creek box culvert where it exits through the westerly wingwall of the box culvert.

CDOT will be applying a Temporary Spray Lining to this pipe in the fall of 2016. It is expected that this lining will reduce the diameter of the pipe by no more than six inches. The Contractor will be required to remove and replace this cross drain.

The Contractor shall enlarge the upstream detention area (Pond H) and construct a new 78" RCP cross drain to convey the 100-year peak flow rate from the existing, off-site drain basin and post-project C-470 improvements. The cross drain shall be replaced from the south side of C-470, under C-470 and tie into a new junction box, within CDOT ROW, and the existing 60" CMP under the adjacent local roadway which will not be replaced. Pond H will be sized and enlarged to mitigate the design flows into the junction box and existing 60 " CMP.

12.2.9.9 Storm Drains at Santa Fe Drive Interchange, Existing Ponds 2 and 3, Erickson Pond and Littleton City Ditch

Release rates from existing Ponds 2 and 3 and the Erickson Pond, as described in the State Highway C-470 & Santa Fe Drive /US 85, Phase 1: Final Drainage Report, PBS&J, December, 2009 (PBS&J Report) and in the Phase III Drainage Report for Wind Crest Phase 1A, must be incorporated into the Project storm drain design.

The proposed preliminary plan requires that new storm drain pipes cross the Littleton City Ditch, which is located just west of the Santa Fe Drive interchange with C-470. The Littleton City Ditch is contained within a pipe at this location and operates as a siphon to convey ditch water from south to north across C-470 ROW.

The Contractor shall design the storm drain system to avoid conflicts with the Littleton City Ditch, or to coordinate with the ditch company to design a relocation of the ditch so that the drainage system performs according to Project standards and criteria and so that the ditch performs according to ditch company standards. The Contractor shall consult with the ditch company, as necessary, to design the ditch crossing according to ditch company standards. The Contractor shall only construct the drainage system that crosses the Littleton City Ditch after the proposed design is approved by the Littleton City Ditch and Accepted by CDOT.

12.2.9.10 Storm Drain at Outfall 1385S, Pond 1390N and Pond 1392S

An existing storm drain system, located along the south side of C-470, east of S. Yosemite Street, collects runoff from C-470 and conveys it under S. Yosemite Street west to Willow Creek. Proposed Outfall 1385S, Pond 1390N and Pond 1392S will discharge to this existing storm drain system.

Existing detention Ponds 2, 3 and B are located upstream of existing Pond 1 (ie. Pond 1392S as described in the DDR) and discharge into Pond 1. The preliminary plan, as described in the DDR, proposes to divert discharges from Ponds 2, 3 and B around Pond 1 into the existing storm drain downstream of the Pond 1 outlet structure. The preliminary plan also proposes to reconstruct the outlet structure of existing Pond 1 to provide water quality treatment and flood detention storage for C-470 runoff.

The Contractor shall analyze the existing and proposed systems and design and construct Ponds 1390N and 1392S so that the post-project design flows do not exceed the hydraulic capacity of the existing storm drain system. The Contractor shall coordinate the design of the drainage system with Lone Tree and CDOT. The Contractor shall document the analysis of the existing and proposed systems in a report submitted to Lone Tree for approval and to CDOT for Acceptance. The Contractor shall construct Outfall 1385S, Pond 1390N and Pond 1392S and the proposed storm drain system connecting the existing storm drain system only after the design is approved by Lone Tree and Accepted by CDOT.

12.2.9.11 Nevada Ditch Crossing at Pond 890S

The outlet pipe for Pond 890S is proposed to cross the Nevada Ditch which traverses C-470 ROW at approximately Station 891+00. The ditch is contained in a pipe that has been in place for over a century and may have historical significance. The ditch is owned and operated by the USACE and connects to “Waters of the US”. Therefore, it is considered “jurisdictional” and under regulations defined in Section 404 of the Clean Water Act. The Contractor shall construct Pond 890S and its outlet pipe to avoid a conflict with the Nevada Ditch in compliance with Project standards and criteria. The Contractor shall coordinate the design of the drainage system to comply with requirements of the USACE and obtain any permits required related to the environmental or historical character of the ditch The Contractor shall construct the drainage system crossing the Nevada Ditch only after the design is approved by USACE and Accepted by CDOT.

12.2.9.12 Last Chance Ditch Crossing at Station 855+00

The Last Chance Ditch is contained in a pipe that traverses the Project at about Station 855+00. The ditch has been in place for over a century and may have historical significance. The ditch is owned and operated by the USACE and connects to “Waters of the US”. Therefore, it is considered “jurisdictional” and under regulations defined in Section 404 of the Clean Water Act. The Contractor shall avoid the design and construction of drainage improvements that conflict with the Last Chance Ditch in compliance with Project standards and criteria. The Contractor shall coordinate the design of the drainage system to comply with requirements of the USACE and obtain any permits required related to the environmental or historical character of the ditch The Contractor shall construct any drainage system improvements crossing the Last Chance Ditch only after the design is approved by USACE and Accepted CDOT.

12.2.9.13 Off-site Runoff Near W. Chatfield Avenue and Platte Canyon Road

Off-site runoff from existing development along W. Chatfield Avenue is being collected in a storm drain system in C-470 at about Stations 834+00 and 840+00. Changes to W. Chatfield Ave. the off-site drainage system along W. Chatfield Avenue are being proposed by Jefferson County to improve the roadway and off-site drainage system. The runoff calculations and proposed improvements are described in the *Draft Phase III Drainage Report*, *West Chatfield Avenue from South Pierce Street to Platte Canyon Drive (SH (75)/Kendall Blvd.*, AECOM, June, 2015. This document is included in the Project Drainage Reference documents. The proposed Project drainage system design, described in Amendment #1 of the DDR includes the collection and conveyance of 100-year peak flows from these offsite areas. According to the *Draft Phase III Drainage Report* the revised system will discharge flows into C-470 right-of-way at S. Lamar Ct. (design points 10, 13A and 13B) and at the beginning of the curve in W. Chatfield Ave. (design point 14A). The as-built drawings from SH 75 (also included in the Project Drainage Reference documents) show that the offsite runoff is combined with runoff from C-470 and conveyed to the S. Platte River at about Station 868+00 through an existing outfall pipe. The Contractor must design and construct the Project storm drainage system to collect and convey 100-year peak flows from the offsite areas and C-470 to the S. Platte River through the existing outfall pipe so that the capacity of the outfall pipe is not exceeded. The Contractor must also design and construct the required stormwater quality treatment for C-470 runoff.

12.2.9.14 Maintenance Access Roads Improvements to Existing Ponds

Existing access roads to Ponds 990N and 1042S are not adequate to provide reliable all-weather access for maintenance. The Contractor shall improve the existing access roads to provide stable maintenance access as described below.

Pond 990N

The Contractor shall improve the existing access road beginning at the northwesterly corner of Pond 990N at County Line Road for a distance of 900 linear feet southerly to the outfall into the pond. The improved access road shall follow the alignment of the existing access road. The existing road surface shall be graded to provide a uniform, smooth subgrade. The graded subgrade shall be covered by 8 inches of Class 6 material meeting CDOT Specification 703.03 to prove a travel surface of no less than 10 feet. The travel surface shall be graded and compacted to provide a smooth, stable road. The Contractor shall submit a typical access road section to HRMD and Douglas County for Approval.

Pond 1042S

The Contractor shall improve the existing access road to the primary outfall pipe at the southerly end of the pond and to the secondary outfall pipe in the northwesterly corner of the pond. The improved access road shall follow the alignment of the current access road along a route to the primary outfall pipe a distance of approximately 1000 linear feet to the pond and Pond 1042S. The access road to the secondary outfall pipe shall be reconstructed from the improved primary

access road a distance of approximately 300 linear feet. The access road shall be improved by excavating a depth of 18 inches below existing grade along the existing alignments and replace the excavated material with Class 2 aggregate meeting CDOT Specification 703.03. The stabilization material should be covered with 8 inches of Class 6 material meeting CDOT Specification 703.03 to provide a travel surface of no less than 10 feet in width. The travel surface shall be graded and compacted to provide a smooth, stable road. The Contractor shall submit a typical access road section to HRMD and Douglas County for Approval.

12.2.9.15 HRMD Pipe 51 Crossing

The HRMD is planning to bore and jack a new cross drain at about Station 991+00. The project is anticipated to be completed in 2016. The design plans for proposed project are included in the Drainage Reference documents. The Contractor shall coordinate the Project design with the proposed crossing through communications with the HRMD and its representatives as necessary to avoid conflicts and to meet Project requirements.

12.3 Construction Requirements

Drainage facilities shall be constructed in accordance with Book 2, the CDOT *Standard Specifications, Standard Plans*, and *M & S Standards* within CDOT ROW or easements. Outside of CDOT ROW or easements, drainage facilities also shall be constructed in accordance with the appropriate Local Agency standards where the Local Agency standards are more stringent.

Drainage facilities shall be designed to accommodate the construction phasing of the Project.

The Contractor shall survey and map constructed EDBs according to Section 6.13 of the CDOT Survey Manual and provide “as-built” volume calculations to confirm the design volume had been provided. The “as-built” EDB mapping shall be included in the As-Built Plans. This work shall be provided to CDOT prior to Final Acceptance. The Contractor shall map for inclusion into CDOT’s GIS system, all new and existing (remaining) outfalls.

Temporary drainage features shall be constructed in accordance with the Accepted Temporary Drainage Plans for each phase or stage of construction. The Contractor shall continuously maintain temporary drainage features until removal/abandonment. All temporary drainage features shall be removed when they are no longer required unless abandonment is Approved by CDOT. The proposed method and materials for abandonment of any temporary drainage feature shall be submitted to CDOT for Approval prior to implementation. Temporary drainage features shall be constructed to comply with Project clear zone requirements and shall not present hazards to the travelling public.

12.3.1 Pipe Material Selection Policy

The Contractor shall comply with the CDOT Design Bulletin Pipe Material Selection Policy which is included in Book 3, except where required pipe materials are specified herein. The most

current version, as signed by the CDOT Chief Engineer at the time of the Request for Proposals (RFP), shall be utilized.

Clarifications of the CDOT Pipe Material Selection Policy are as follows:

1. Trial installations are not allowed on this Project.
2. Contractor shall be required to sample soil and water.
3. "Project Manager" implies "Contractor".
4. Contractor shall provide a Sampling Schedule for Pipe Selection for CDOT Review.
5. Pipe material selection shall be submitted to CDOT for Acceptance as part of the Drainage Reports.
6. Aluminum alloy pipe shall not be used.

12.3.2 Project Special Provisions

Subsection 603.03 shall include the following:

> The Contractor shall provide a mockup for any connection between HDPE pipe and concrete drainage facilities for CDOT review and Acceptance prior to construction.

Subsection 603.07(a) shall include the following:

> Joints for all circular reinforced pipes shall be made with confined rubber gaskets. Reinforced concrete collars shall be required at all nonstandard joints (not tongue and groove or bell and spigot), and at all connections to existing pipe.

Subsection 603.07(c) shall include the following:

> All welding of HDPE pipe and fittings will be performed by qualified and certified personnel trained by Extrusion Welding. Certifications shall be provided to CDOT prior to performing any welding for the Project.
>
> In order to limit thermal expansion, all HDPE connections made to concrete structures shall be made a minimum of 24 hours after HDPE pipe has been installed and backfilled.

Subsection 624.03 shall include the following:

> Joint systems for cross drains and storm drains shall be watertight. All storm drain and cross drain segments between junction structures, including inlets, and between the ends of cross drains must be video or TV inspected following installation and backfill. Video/TV inspection shall be sufficient to clearly inspect the circumference of each joint to verify joint construction is in accordance with the manufacturer's recommendations and Contract Documents. The Contractor shall provide a DVD of videos and inspection reports for each inspected segment. Reports shall identity the location of any discovered deficiencies and the proposed method of correction. Prior to construction the Contractor must submit a Method Statement for constructing watertight joints for approval by CDOT. Construction and inspection of joints shall be performed by the Contractor in accordance with methods approved by CDOT. Should any installations fail

to meet the requirements, it shall be corrected at the Contractor's expense so that inspection requirements are satisfied.

12.4 Deliverables

12.4.1 Drainage and Water Quality Reports

12.4.1.1 Drainage Reports

A Drainage Master Plan shall be prepared and submitted by the Contractor for Acceptance by CDOT with the Preliminary Design Plans (30%) submittal. The master plan shall provide sufficient hydrologic and hydraulic calculations to demonstrate how the Contractor will comply with the terms of the Contract Documents related to drainage for the Project. The master plan shall include a tabulation of drainage basins and pre-project and post-project peak flow rates to demonstrate how project requirements relative to peak flow attenuation will be provided. The tabulation shall be itemized by an appropriate logical drainage system characteristic, such as outfall and pond locations so that compliance with CDOT commitments for providing flood control facilities can be easily identified and documented in interim reports as the Project is completed. If the Interim or Final Interim Drainage Reports require modifications to the Drainage Master Plan, an addendum to the Drainage Master Plan should be submitted for Acceptance prior to proceeding with design. The Acceptance requirements for the Drainage Master Plan supersedes the Review designations defined in Section 3 for other Preliminary Design Plan elements.

Interim Drainage Reports shall be prepared by the Contractor and submitted for Review with the Pre-Released for Construction (RFC) Review Documents submittal that include the subject drainage facilities. Interim Drainage Reports shall coincide with construction phasing and with a logical grouping of drainage system improvements, such as, by outfall location. Upon completion of the comment resolution process outlined by the Contractor's Approved QMP resulting from the Pre-Released for Construction (RFC) Review Documents submittal, the Contractor shall submit a Final Interim Drainage Report for Acceptance with the Final RFC Documents Submittal.

A Final Drainage Report, incorporating addenda to previously submitted Final Interim Drainage Reports and design and field revisions, shall be compiled and prepared by the Contractor and submitted for Acceptance with the Final Design Plans (100%) submittal.

Interim Drainage Reports, Final Interim Drainage Reports, and the Final Drainage Report shall demonstrate the adequacy of the drainage facility design to meet design criteria for the Basic Configuration and for the Ultimate Configuration, as described in the REA, WQTR and DDR, and to satisfy requirements in third party agreements.

The drainage reports shall follow the documentation procedure in Chapter 4 of the CDOT *Drainage Design Manual*.

The drainage reports shall include the following:

1. Basic design data, design assumptions, hydrologic and hydraulic methodologies, assumptions, model inputs and outputs, detailed calculations, computations, and computer printouts, relevant design criteria, circumstances influencing design, discussion of all drainage issues and drainage facilities, appropriate maps, figures, and plans.
2. Rationale for sizing and selection of all drainage elements, including catch basins, storm drain systems, cross drains, ditches, swales, permanent BMPs, extended detention basins, and pipe materials selection
3. Hydraulic data sheets with a summary of hydraulic design information for each Storm Drain and Cross Drain.
4. A delineation of contributing basins, existing drainage patterns for both highway and cross-drainage flows, drainage parameters, permanent BMPs, extended detention basin sizing, discharge characteristics, and other information necessary for the design of the drainage system. All drainage reports shall include documentation of any tributary flows from areas outside of each construction segment or leaving the construction segment into off-site areas within peak flow mitigation, as defined by the Contractor.
5. Documentation that the proposed runoff will be detained and treated in accordance with Book 2 Section 12 and all drainage and water quality permits or documentation of Acceptance by receiving Local Agencies of peak flows not detained in accordance with Book 2, Section 12.
6. Documentation of existing drainage discharge rates, outfall locations and pond release rates.
7. Documentation of the impact of proposed drainage designs on existing drainage facilities and documentation of Acceptance by Local Agencies receiving discharges from the proposed design if the discharges are larger than the Local Agency approved design flow rates for the existing drainage facilities.
8. Documentation of compatibility with the Ultimate Configuration.
9. Calculations, analysis, and all related information used in developing conclusions and recommendations for BMPs in accordance with CDOT 2014 Interim New Development Redevelopment (2014 NDRD) requirements.
10. Maintenance Exhibit, showing entities (CDOT, and/or HRMD, Lone Tree or others) responsible for maintenance of various portions of the project area.

In addition to the documentation procedure in Chapter 4 of the CDOT *Drainage Design Manual*, the Contractor shall closely follow the report outline below. The section and subsection headings shall be maintained at a minimum. If a section or subsection is not used, the reason it is not applicable to the Project shall be specified in the report. New sections or additional subsections shall be added, as necessary, to fully document the drainage design.

Final Interim Drainage Reports shall be organized so that a Final Drainage Report can be assembled that includes Final Interim Drainage Reports in a systematic, organized manner and consistent with master plans and construction phases.

To facilitate the future construction of the Ultimate Configuration improvements the final condition of constructed Project improvements for the Interim Configuration must be well documented.

Drainage Report Outline

1 INTRODUCTION
- 1.1 Location of Improvements
- 1.2 Description of Improvements
- 1.3 Discussion of Drainage Investigation

2 CROSS DRAINAGE, DRAINAGEWAY, AND IRRIGATION DITCH CROSSINGS
- 2.1 Location and General Discussion
- 2.2 Hydrology and Design Flow Development
- 2.2.1 Information Sources
- 2.3 Agency Coordination (i.e. FEMA, local agencies)
- 2.4 Description of Structural Design (i.e. for non-CDOT standard CBCs)
- 2.5 Hydraulic Design
- 2.6 Irrigation Ditch Crossings
- 2.7 Drainageways and Floodplains
- 2.8 Scour Analysis
- 2.9 Bank Stabilization

3 ROADWAY DRAINAGE SYSTEMS
- 3.1 General Discussion
- 3.2 Design Coordination
- 3.2.1 Adjacent Segments
- 3.2.2 Agency Coordination
- 3.3 Drainage Basin Delineations & Characterization
- 3.3.1 Existing Basins
- 3.3.2 Proposed Basins
- 3.4 Hydrology and Design Flow Development
- 3.5 Pavement, Median and Roadside Drainage
- 3.5.1 Inlet/Catch Basin Spacing Design
- 3.5.2 Storm Drain Design
- 3.5.3 Roadside Ditch and Channel Design
- 3.5.4 Erosion Control Design

4 PERMANENT BEST MANAGEMENT PRACTICES
- 4.1 Assumptions and Methodologies
- 4.1.1 Allowable Release Rate Discussion

4.2 Hydrology and Hydraulics
4.2.1 Storage and Outlet Design Documentation
4.3 Adherence to the CDOT MS4 Permit and NDRD requirements
4.3.1 Compliance with Mitigation Fund tracking requirements

5 APPENDICES
5.1 Hydrologic Analysis
5.1.1 On-Site Hydrology
5.1.2 Off-Site Hydrology
5.1.3 Precipitation Data
5.1.4 Soil Survey
5.1.5 Land Use
5.1.6 FEMA Maps
5.2 Hydraulic Analysis
5.2.1 Spread width, Inlet and Storm Drain Calculations
5.2.2 Roadside Ditch and Channel Calculations
5.2.3 Hydraulic Grade Line Calculations
5.2.4 Drain Outfalls, Scour and Erosion Control Calculations
5.2.5 Sub-Drainage Systems
5.3 Permanent Best Management Practices
5.3.1 Extended Detention Basin Calculations
5.3.2 Stage Storage Calculations
5.3.3 Trickle Channel Calculations
5.3.4 Water Quality Structure Calculations
5.4 Basin Maps
5.4.1 Existing and Proposed On Site Basin Maps
5.4.2 Off Site Basin Maps (full size 22” x 34” sheets)
5.5 Floodplain Development Permits and Map Revision Documentation
5.6 Maintenance Exhibit

The Contractor shall submit 3 hard copies of all Interim Drainage Reports, Final Interim Drainage Reports and the Final Drainage Report. All drainage reports shall be signed and sealed by a Colorado Licensed Professional Engineer.

After all design is completed, and all design and field revisions have been incorporated into the drainage report, the Contractor shall submit a final electronic copy of the Final Drainage Report, signed and sealed by a Professional Engineer registered in the State of Colorado, in PDF format.

All drainage reports shall include electronic copies of all computer analysis input and output files in the native file format.

12.4.1.2 Water Quality Reports

The Contractor shall prepare and submit a Water Quality Master Plan, for CDOT Approval with the Preliminary Design Plans (30%) submittal. The master plan shall describe how the Contractor will comply with the terms of the Contract Documents relative to the treatment of stormwater runoff for water quality. The master plan shall provide a sufficient analysis of drainage patterns and quantities to demonstrate that Project goals and commitments will be achieved. The master plan shall include a tabulation of impervious areas for which runoff will be treated for water quality as required by the Contract Documents. The tabulation of impervious areas shall be itemized by an appropriate and logical drainage system characteristics, such as by drainage basin, outfall or pond locations. If the Interim or Final Interim Water Quality Reports require modifications to the Water Quality Master Plan, an addendum to the Water Quality Master Plan should be submitted for Approval prior to proceeding with design. The Approval requirements for the Water Quality Master Plan supersedes the Review designations defined in Section 3 for other Preliminary Design Plan elements.

The Water Quality Report shall be an independent report that documents permanent water quality design decisions for compliance with the Project commitments and CDOT MS4. The report shall document the basis for all decisions made to comply with the REA, WQTR, DDR, third party agreements and the 2014 NDRD program, as part of CDOT's overall MS4 permit.

Interim Water Quality Reports shall be prepared by the Contractor and submitted for Review with the Pre-Released for Construction (RFC) Review Documents submittal that include the subject drainage facilities. Interim Water Quality Reports shall be organized to represent the logical progression of the project and to provide "place holders" for later interim reports so that the final report is a compilation of all of the interim reports. Upon completion of the comment resolution process outlined by the Contractor's Approved QMP resulting from the Pre-Released for Construction (RFC) Review Documents submittal, the Contractor shall submit a Final Interim Water Quality Report for Acceptance with the Final RFC Documents Submittal.

A Final Water Quality Report, incorporating Final Interim Water Quality Reports content, addenda to previously reviewed reports and design and field revisions, shall be prepared by the Contractor and submitted for Acceptance with the Final Design Plans (100%) submittal. No Addenda to the Final Water Quality Report will be allowed.

The Water Quality Reports shall reference the applicable drainage report for all technical aspects and design calculations.

The Contractor shall submit 3 hard copies of all Interim Water Quality Reports, Final Interim Water Quality Reports and the Final Water Quality Report. All Water Quality Reports shall be signed and sealed by a Colorado Licensed Professional Engineer.

After design is completed, and all design and field revisions have been incorporated into the water quality report, the Contractor shall submit a final electronic copy of the Final Water Quality Report, signed and sealed by a Professional Engineer registered in the State of Colorado, in PDF format.

The Water Quality Reports shall closely follow the report outline and requirements as listed in the Region 1 *Consultant Helper: Permanent Water Quality Report*, CDOT, dated 02/21/2014, as summarized below, but modified to be consistent with Project goals and requirements.

The Water Quality Report Outline, as listed in the above mentioned document, and as summarized below, shall be maintained, at a minimum. If a section or subsection is not used the reason it is not applicable to the Project shall be specified in the report. New sections or additional subsections shall be added as necessary to fully document the Project design.

The Water Quality Reports shall include the following:

1. Calculations, analysis, and all related information used in developing conclusions and recommendations related to the CDOT NDRD requirements and other commitments, such as those included in the REA, WQTR and DDR, including alternatives, omissions, and locations shall be compiled in the Permanent Water Quality Report.
2. All assumptions and criteria related decisions shall be documented.
3. Design decisions shall be documented and based on sound engineering principles and optimal maintenance access/safety/mechanical cleaning ability.
4. All related references shall be cited in the text, and provided in the Report.
5. Data and information shall be documented through all stages of the project as to provide successors with all information.

   Documentation shall be organized to logically lead the reader from the project scoping, background and resulting water quality impacts; through the alternatives, calculations and reasons for decisions; to final design, maps, and tables showing how the design meets CDOT's NDRD requirements.

Water Quality Report Outline

Table of Contents

1. Introduction: Description of Project
   1.1. Geographic Location
   1.2. Proposed project
2. Discussion of MS4-2014 NDRD Requirements and REA/WQTR/DDR Commitments
   2.1. Compliance with Mitigation Fund tracking requirements.
3. Permanent Water Quality BMPs
   3.1. Describe existing Water Quality BMPs
   3.2. PWQ BMP Options Considered
   3.3. Recommended BMPs
   3.4. NDRD Exhibit Map
4. Maintenance and Operation
   4.1. Narrative description of the facility
   4.2. Narrative description of how to access the facility

4.3. Narrative description of what maintenance work will need to be done to ensure continued effectiveness of the facility
4.4. Documentation of commitments

Appendix 1: MS4 Inventory Questionnaire Form
Appendix 2: Final Plan Set for Hydraulics and Permanent Water Quality Sheets
Appendix 3: Any Maintenance IGA related to the project, signed and dated.

12.4.2 Drainage Design Plans

The Contractor shall prepare plans for all drainage related facilities for the Project in a format that follows the documentation procedure in chapter 4 of the CDOT *Drainage Design Manual*, and the *CDOT CADD Manual* and *CDOT Drafting Manual*.

The Contractor shall submit all applicable plans with each Drainage Report.

All deliverables shall follow the Quality Management Plan for the Project as described in Book 2, Section 3, Quality Management.

The Contractor shall include the following for all drainage plan deliverables:

PLAN VIEW

1. Provide the location of all existing and proposed storm drains. Provide a label for each proposed storm drain location. The Contractor shall establish a labeling system that is specific to each proposed storm drain system and provide a table to summarize all pertinent information. The table shall include at a minimum the Drain Line and Sheet Number where the profile can be found.
2. Provide the location of all existing and proposed inlets, manholes, end sections, and outlet protection. Provide a label for each proposed inlet, manhole, end section, outlet structure and outlet protection. Include a table that summarizes all pertinent information. The table shall include, at a minimum, the Label ID, Station & Offset, Item, Length, Pay Depth, and Notes.
3. Provide all existing and proposed grading.
4. Provide all Utility locations and relocations.
5. Provide location of ROW lines.

PROFILES

1. Provide profiles for all proposed storm drains. Include the Label ID from plan view sheets, station and offset, invert elevations, rim elevations, structure depth, slopes, sizes, material, utility crossings, existing and proposed finished grade lines, the design flow for the 10-year and 100-year event, and the calculated HGL for the 10-year and 100-year event.

2. Provide profiles for all proposed cross drains. Include the Label ID from plan view sheets, station and offset, invert elevations, slopes, sizes, material, utility crossings, and existing and proposed finished grade lines. Provide the drainage area of contributing basin, 100-year discharge, and headwater elevation on all applicable profile sheets for cross drains.

DRAINAGE DETAILS

Include details for all non-standard CDOT items.

PWQ BMP DETAILS FOR EDB

1. Provide each EDB in plan view. Provide existing and proposed contours that define limits of overall facility. Include access roads, overflow location or structure, forebay, trickle channel, micro-pool, and outlet structure. Include all locations of Utilities and property lines. Include point labels to define location and elevations within the facility.
2. Provide a table summarizing each point label. The table shall include at a minimum the Point Label, Station & Offset, Northing, Easting, Elevation and Notes.
3. Provide a cross section of the EDB from where flows enter the pond to the outlet structure. Label elevations for the WQCV. Include slopes and elevations of all features.
4. Provide a geometry plan of the EDB from where flows enter the pond to the outlet structure. Include access roads.
5. Provide specific details for the forebay, trickle channel, micro-pool, and outlet structure.

12.4.2.1 Temporary Drainage Plans

Temporary Drainage Plans shall be submitted concurrently with each Traffic Control Plan (TCP) and any major revision to the TCP and shall address temporary drainage for each phase or stage of construction. The Temporary Drainage Plans shall demonstrate adequate drainage to minimize hydroplaning and icing problems and include the following at a minimum:

1) Catchment areas for each existing, temporary, or permanent drainage feature (pipes, inlets, ditches, etc.) that are planned to be utilized for temporary drainage. Each drainage feature shall be identified by size and type and be sized appropriately for the respective catchment area. The minimum size pipe for temporary drainage shall be 12 inches.
2) Drainage feature materials shall be identified in the plans and be selected to prevent damage or failure while in service.
3) Location, method, and details for temporary connections to any drainage system.
4) Method of restoring impacts from temporary connections to drain systems that are to remain when connections are removed.
5) Label each proposed location of existing, temporary, or permanent drainage features (pipes, inlets, ditches, etc.) that are planned to be utilized for temporary drainage. Establish a labeling system that is specific to each proposed storm drain system and provide a table to summarize all pertinent information. The table shall include the label designation, storm drain system, controlling invert and top of drainage feature elevations, and sheet number where the drainage feature can be found.

12.4.3 Drainage As-Built Documents

Clearly label and locate all items of Work with station, offset, coordinates, and elevation information based on surveys of what was actually built in the field. Provide summaries of all As-Built drains with the following hydraulic information, at a minimum: pipe/culvert size, invert elevations, slope, 10-year flow (Q10), 100-year design flow (Q100), and HGL.

Provide certification for the EDB as-built grading, volumes, water surface elevations and orifice plates stamped by a Colorado Professional Engineer.

The Contractor shall maintain As-Built Temporary Drainage Plans for the duration of construction including any variation from the Accepted Temporary Drainage Plans. CDOT shall be immediately notified of any variation from the Accepted Temporary Drainage Plans at which point a revised Temporary Drainage Plan may be required at the sole discretion of CDOT. Dates of installation and removal/abandonment for each temporary drainage feature (pipes, inlets, ditches, etc.) shall be updated and noted weekly. If abandonment of any temporary drainage feature is Approved by CDOT the As-Built Temporary Drainage Plans shall include specific notation of the type of abandonment. CDOT shall have access to review the As-Built Temporary Drainage Plans at its sole discretion.

12.4.4 Deliverable Table

At a minimum, the Contractor shall submit the following to CDOT and all applicable review agencies, or third parties, for review, Approval, and/or Acceptance. The Contractor shall identify and coordinate all required Approvals by CDOT and outside agencies.

Deliverable	CDOT Review, Acceptance or Approval	Schedule
Master Drainage Plan	Acceptance	As part of the Preliminary Design Plans (30%) submittal
Master Water Quality Plan	Approval	As part of the Preliminary Design Plans (30%) submittal
Interim Drainage Reports	Review	With the Pre-Released for Construction (RFC) Review Documents submittal
Interim Water Quality Reports	Review	With the Pre-Released for Construction (RFC) Review Documents submittal
Interim Bridge Hydraulics Reports	Review	With the Pre-Released for Construction (RFC) Review Documents submittal
Final Interim Drainage Report	Acceptance	As part of the Final RFC Documents submittal
Final Interim Water Quality Report	Acceptance	As part of the Final RFC Documents submittal
Final Drainage Report	Acceptance	As part of the Final Design Plans (100%) submittal
Final Water Quality Report	Acceptance	As part of the Final Design Plans (100%) submittal
Final Bridge Hydraulics Report	Acceptance	As part of the Final RFC Documents submittal
Revised Floodplain Development Permit (as required)	Acceptance	Prior to Released for Construction Documents
FEMA Approved CLOMR (as required)	Acceptance	Prior to Released for Construction Documents
FEMA Approved LOMR (as required)	Acceptance	Prior to Final Acceptance
Sampling Schedule for Pipe Selection	Review	Prior to applicable Release for Construction Documents
Groundwater Elevations at Pond Locations	Review	Prior to NTP2
SWMP Site Map	Acceptance	Prior to applicable Release for Construction Documents
SWMP Plan(s)	Acceptance	Prior to applicable Release for Construction Documents
EDB Certification	Acceptance	Prior to Final Acceptance

Deliverable	CDOT Review, Acceptance or Approval	Schedule
Temporary Drainage Plans	Acceptance	Concurrently with Each Traffic Control Plan (TCP) and Any Major Revision to the TCP
Temporary Drainage Plan As-Builts	Review	Weekly

13.0 ROADWAYS

13.1 Administrative Requirements

The Contractor shall comply with the requirements of the following manuals and standards (latest versions at Proposal Due Date) for the design and construction of the Work for the Project.

13.1.1 C-470, Ramps, and Trails

1. CDOT Roadway Design Guide 2005 (Updated April 2014)
2. AASHTO, A Policy on Geometric Design on Highways and Streets 2004
3. AASHTO, Roadside Design Guide, 3rd Edition 2006
4. CDOT, Standard Plans List, M & S Standards, July 2012
5. CDOT, Standard Specifications for Road and Bridge Construction, 2011
6. FHWA Interstate Access Report (IAR)
7. CDOT Cable Barrier Guide, June 2009
8. AASHTO, Guide for the Development of Bicycle Facilities
9. AASHTO, Guide for High-Occupancy Vehicle Facilities

13.1.2 Local Roadways

Roadways controlled or maintained by Local Agencies other than CDOT shall be designed and constructed according to the Local Agency's standards and requirements. The additional manuals and standards are as follows:

1. AASHTO, A Policy on Geometric Design on Highways and Streets 2004
2. AASHTO, Roadside Design Guide, 3rd Edition 2006
3. State of Colorado, State Highway Access Code
4. CDOT, Standard Specifications for Road and Bridge Construction, 2011

Other requirements provided in Book 3 shall govern the design and construction as applicable.

13.2 Design Requirements

13.2.1 Design and Plan Submittals

In addition to the submittal requirements specified in this Section, the Contractor shall submit design and plan documents for CDOT Review and Acceptance, as required in Book 2, Section 3 - Quality Management.

13.2.2 Traffic Analysis and Design

The IAR Evaluation provides draft design year traffic volumes, Measures of Effectiveness (MOE's) and other operational parameters for the Project. The Project design shall meet or exceed the MOE's and other operational parameters identified in the IAR Evaluation, utilizing Traffic Volumes from the Level III Traffic and Revenue Study.

The design of the Basic Configuration and Temporary Configuration shall provide equivalent or better operations for C-470 mainline, ramps, and ramp intersections for 2014 and 2035 as described in the IAR Evaluation.

13.2.3 General Design Requirements by Project Element

13.2.3.1 Basic Configuration Accommodation

The infrastructure constructed with the Project shall consider and accommodate the Ultimate Configuration, including but not limited to horizontal/vertical geometry and clearances to Structures.

The Contractor shall prepare and submit the Preliminary Design Plans (30%) for Review, Pre-Released for Construction (RFC) Review Documents for Review, and Final RFC Documents for Acceptance according to procedures of its Approved Quality Management Plan.

13.2.4 Cross Slope and Superelevation

13.2.4.1 Normal Cross Slope

All new and reconstructed pavement sections shall have a normal cross slope of 2 percent.

For pavement widening sections, the widened section shall have a normal cross slope of 2 percent.

13.2.4.2 Superelevation Rates

Superelevation runout and runoff lengths for C-470 and interchange ramps shall be designed based on the ultimate configuration. Superelevation transition design shall comply with the design criteria and methodology of the current CDOT Roadway Design Guide, AASHTO, A Policy on Geometric Design on Highways and Streets, and CDOT Standard Plans List of M & S Standards.

An analysis of edge profiles (at the location of the shoulder/lane line) shall be performed at location of superelevation transitions on the C-470 mainline to verify that edge profiles will meet normal profile design criteria. Superelevation transitions shall be modified if necessary to meet this criteria.

Superelevation transitions shall be designed to minimize the occurrence of 0 percent cross slopes on bridge decks or on profile grades flatter than 0.5 percent.

13.2.5 Stopping Sight Distance

Stopping sight distances and decision sight distances shall meet or exceed the requirements of Exhibit A Roadway Design Criteria in this Section. Stopping sight distances shall be determined in accordance with the CDOT Roadway Design Guide and AASHTO, A Policy on Geometric Design on Highways and Streets.

13.2.6 Decision Sight Distances

Alignment design on the mainline shall provide for obtaining decision sight distances on the mainline of C-470 to all exit ramp gores, and at ramp approaches to ramp intersections. Decision sight distances are provided in the Roadway Design Criteria Table, Appendix A.

13.2.7 Fill and Cut Slopes and Clear Zones

The Contractor shall design cut and fill slopes to obtain clear zones and avoid the need for guardrail wherever possible. Where clear zones cannot be obtained within CDOT ROW, guardrail shall be required.

Clear zones on C-470 shall be 34 feet. The clear zones shall be measured from the outer edge of travel way of the C-470 auxiliary lanes or through lanes. Ramps shall be designed in accordance with the recommendations of the AASHTO Roadside Design Guide, Table 3-1.

13.2.7.1 Roadside Slopes Adjacent to Pavement

(Note: All slopes stated herein are in terms of horizontal: vertical)

The Point of Slope Selection (POSS) is defined as the location at which the roadside slope adjacent to the pavement ends and the cut or fill slope begins. Width and slope of the area between the edge of pavement (or sidewalk) and the POSS shall be as follows:

1. Mainline C-470: 12 feet minimum at a 6:1 slope
2. Ramps: 12 feet at a 6:1 slope

13.2.7.2 Fill Slopes

Fill slopes beyond the POSS shall be designed and constructed in accordance with the following priority.

1. Use 6:1 slopes where fill heights are less than 4 feet, and matches with existing conditions that can be obtained within the Project limits.
2. Use 4:1 slopes where fill heights are greater than 4 feet but less than 10 feet, and matches with existing conditions that can be obtained within the Project limits.
3. Use 3:1 slopes where fill heights are less than 10 feet and slopes steeper than 4:1 are required to match existing conditions within the Project limits.
4. Use 3:1 slopes where fill heights exceed 10 feet, and matches with existing conditions can be obtained within the Project limits and clear zone can be obtained within the Project limits.
5. Where the above conditions cannot be obtained, the Contractor may use any of the following design approaches:

A. Use 3:1 slopes with guardrail protection where not otherwise prohibited by the Aesthetic Plans and Details.

B. Use retaining walls as necessary, with guardrail protection. Where retaining walls are used, provide a traversable surface with a maximum 6:1 cross slope and a minimum 10 feet width between face of wall and ROW or Permanent Easement line, fence line, or other obstruction.

Fill slope areas shall be designed to prevent Roadway and slope drainage from flowing onto adjacent properties.

13.2.7.3 Cut Slopes

Cut slopes beyond the POSS shall be designed and constructed in accordance with the following priorities:

1. Cut slopes must be transitioned at the match with the 6:1 slopes adjacent to Roadway pavement in such a manner to comply with the recommendations of the AASHTO, Roadside Design Guide.
2. Use 4:1 or flatter slopes for cut slopes where matches with existing conditions can be obtained within the Project limits.
3. Use 3:1 slopes for cut slopes where such slopes steeper than 4:1 are necessary to obtain matches with existing conditions within the Project limits.
4. Where the above conditions cannot be obtained, the Contractor may use any of the following design approaches:

    A. Use 3:1 slopes with guardrail protection where not otherwise prohibited by the Aesthetic Plans and Details.

    B. Use retaining walls as necessary, with guardrail protection to obtain matches with existing conditions within the Project limits. Where retaining walls are used, locate to avoid landscaping and maintenance areas of less than 10 feet in width.

All cut slopes shall be rounded at their matches to provide a pleasing appearance.

13.2.7.4 Retaining Walls

Retaining walls shall be used as necessary. All retaining walls shall be designed to accommodate the ultimate C-470 project.

The following retaining walls have been identified:

Name	Name	Name
Wall 790+50 N (Fill)	Wall 1004+00 N (Cut)	Wall 1213+75 S (Fill)
Wall 838+25 N (Cut)	Wall 1004+50 S (Cut)	Wall 1243+75 S (Fill)
Wall 910+25 N (Fill)	Wall 1036+00 S (Fill)	Wall 1308+50 S (Cut)
Wall 929+00 S (Cut)	Wall 1036+40 N (Fill)	Wall 1308+50 N (Cut)
Wall 930+50 N (Cut)	Wall 1074+86 N (Cut)	Wall 1331+75 N (Fill)
Wall 939+00 S (Fill)	Wall 1098+35 N (Cut)	Wall 1331+75 S (Fill)
Wall 943+00 N (Fill)	Wall 1142+00 N (Fill)	Wall 1384+50 N (Fill)
Wall 948+10 N (Fill)	Wall 1147+50 N (Fill)	Wall 1394+90 N (Fill)
Wall 950+90 N (Fill)	Wall 1198+90 N (Cut)	Wall 1403+40N (Fill)
Wall 951+35 S (Fill)	Wall 1200+30 S (Cut)	

13.2.8 Guardrail

Guardrail shall be required wherever clear zone requirements cannot be achieved.

Median barrier is required along the entire length of C-470. Where the width between opposing inside edge of pavements is less than 24 feet, the median shall have concrete barrier with a concrete glare screen in accordance with CDOT Standard M-606-13 for medians. Where the width between opposing inside edge of pavement is 24 feet or greater, Tensioned Cable Barrier may be used according to CDOT's Cable Barrier Guide.

Guardrail along the outside shoulders of C-470 shall be concrete barrier. Guardrail Type 3 will not be allowed on this Project.

All concrete barriers shall be cast-in-place. Precast barriers are not allowed for permanent installations.

13.2.9 Interstate Access

CDOT has obtained an Interstate Access Evaluation Approval from FHWA for the Basic Configuration. The Contractor shall fully comply with the design included in the IAR Evaluation unless otherwise Approved by CDOT. The Contractor shall be responsible for obtaining FHWA approval for any modifications to the IAR Evaluation based on the final design of the project and will utilize Traffic Volumes from the Level III Traffic and Revenue Study.

13.2.10 Trails

Four existing trails have been identified within the project area; Centennial Trail (C-470 Trail), Highline Canal Trail, Willow Creek Trail, and the Mary Carter Greenway Trail. Where reconstruction is required, all trails shall be reconstructed with Concrete Bikeway (6 Inch). The trails defined in Book 2, Section 13, Roadways, trails shall be underlain by 4 inches of ABC Class 6 material and 24 inches of subgrade moisture treatment and recompaction. The ABC Class 6 material and the subgrade moisture treatment/recompaction shall extend to the outer limits of the bikeway pavement, plus one foot on each side. Contractor shall coordinate with Local Agencies to obtain approval for duration of trail closures and detours, and minimize impacts to trail users.

13.2.10.1 C-470 Trail

The C-470 Trail parallels the C-470 highway for its entire length. The trail shall remain open during construction, with adequate paved detour routes within the CDOT ROW to ensure bicycle and pedestrian safety.

1. Reconstruct the C-470 Trail where widening of C-470 mainline, relocation of ramps, and new ramps conflict with existing trail.
2. Construct trail grade separation at Quebec as shown in Exhibit A – Basic Configuration to include the following:
    A. Full trail grade separation under the westbound off-ramp and westbound on-ramp
    B. Full trail grade separation under Quebec Street
    C. Local street connection to Quebec Street east and west of Quebec Street
3. Construct trail grade separation at Colorado Boulevard as shown in Exhibit A – Basic Configuration to include the following:
    A. Full grade separation under Colorado Boulevard
    B. Local street connection to Colorado Boulevard east and west of Colorado Boulevard
    C. Local connects to existing neighborhoods as they exist prior to construction

Any impacts to the existing trail system will require reconstruction or realignment of the trail system within the CDOT ROW. See Book 2 – Chapter 5 Environmental for closure and detour requirements

13.2.10.2 High Line Canal Trail

A portion of the C-470 Trail also serves as part of the High Line Canal Trail, which is maintained by Highlands Ranch Metropolitan District (HRMD). The High Line Canal Trail crosses under C-470 in a concrete box culvert, which is to be extended to accommodate the additional lanes on C-470. Trail reconstruction is required for the limits of the box culvert widening and the limits required to tie into the existing High Line Canal Trail. Temporary trail closure and detour will be required during the construction of the culvert extension. See Book 3, C-470 Corridor Revised Environmental Assessment, for preferred detour route.

13.2.10.3 Willow Creek Trail

The Willow Creek Trail, located west of Yosemite Street, crosses under C-470 through a concrete box culvert. This trail is maintained by South Suburban Parks and Recreation District (SSPRD). Trail reconstruction is required for the limits of the box culvert widening and the limits required to tie into the existing Willow Creek Trail. Temporary trail closures will be

required during the construction of the culvert extension. See Book 3, C-470 Corridor Revised Environmental Assessment, for preferred detour route.

13.2.10.4 Mary Carter Greenway Trail

The Mary Carter Greenway Trail, owned by U.S. Army Corps of Engineers (USACE) and maintained by SSPRD, crosses under C-470 on the west bank of the South Platte River. The Mary Carter Greenway Trail shall be reconstructed to have a 12' minimum vertical clearance to accommodate equestrian use. The trail reconstruction shall accommodate a 10' Wildlife Crossing between the trail and the Platte River. The 10' Wildlife Crossing shall be native seeding and have a slope no steeper than 10:1. Mary Carter Greenway Trail crossing shall be closed during demolition and construction of the Platte River Bridge. See Book 3, C-470 Corridor Revised Environmental Assessment, for preferred detour route.

13.2.10.5 Trail Design Criteria

The following Trail Design Criteria shall be used:

Proposed Tier 1 Trail Design Criteria		
Criteria Category	**Proposed Criteria**	**Comments**
Highway Functions		
Functional Classification	Shared Use Path	
Design Criteria and Controls		
Design Speed	14 MPH	CDOT Design Guide 14.2.2
Terrain	Rolling	Obtained from CDOT website
Horizontal Alignment		
Minimum Centerline Curve Radius	41	CDOT Design Guide 14.2.7 Table 14-4
Maximum Superelevation, e_{max} / Cross slope	2%	CDOT Design Guide 14.2.5
Axis of Rotation Location	Edge of Trail	
Vertical Alignment		
Maximum Grade, %	5%	CDOT Design Guide 14.2.8
Minimum Grade, %	0.5%	AASHTO Bicycle Guide Section 5.2.7
Minimum Length of Curve, feet	Varies	CDOT Design Guide 14.2.3.3 Table 14-3
Vertical Clearance		
Minimum Vertical Clearance	10' (12' Mary Carter Greenway Trail)	CDOT Design Guide 14.2.10.1
Cross Section		
Trail Width	10'	CDOT Design Guide 14.2.4
Z-Slope, feet	2'	CDOT Design Guide 14.2.6
Trail Cross Slope, %	1%	CDOT Design Guide 14.2.5
Centerline Grade (Ramps)	5% to 8.3%, rise 2.5' max, landing length 5' min	CDOT Design Guide 14.2.10.2
Design Vehicle	Typical Upright Adult Bicyclist	
Sight Distance		
Stopping Sight Distance	93	CDOT Design Guide 14.2.3.1 Table 14-2
Roadside Design		
Max Foreslopes	1V:3H	CDOT Design Guide 14.2.6
CDOT Design Guide = Colorado Department of Transportation Roadway Design Guide (2005) AASHTO Bicycle Guide = AASHTO Guide for the Development of Bicycle Facilities (2012)		

13.2.11 Design Exceptions

13.2.11.1 Identified Design Exceptions

The following design variances have been approved by FHWA for this Project:

C-470 Interchange – Geometric Exceptions				
No.	**Item**	**Design Criteria**	**Design Exception**	**Comments**
DE-01	Grade – Exceed Maximum	4% maximum grade along C-470	Exceed maximum grade of C-470 between Lucent Boulevard and US 85; approximate stations 937+00 to 954+50.	Exceed 4% profile grade along C-470, by maintaining the existing 5.704% profile grade
DE-02	Grade – Exceed Maximum	5% maximum grade along C-470 Ramps	Exceed maximum 5% grade of C-470 off ramp to US 85.	Exceed 5% profile grade along C-470 off ramp to US 85, by maintaining the 6.75% down grade.
DE-03	Inside Shoulder Width	Inside shoulder width for 6 lane freeway is 10'. For managed lane facilities, the desirable inside shoulder width is 10'.	Reduced inside shoulder width on westbound C-470 between approximate stations 984+86 to 1014+04, near Lucent Boulevard.	Reduced inside shoulder width of 4' for approximately 2,918 feet.
DE-04	Inside Shoulder Width	Inside shoulder width for 6 lane freeway is 10'. For managed lane facilities, the desirable inside shoulder width is 10'.	Reduced inside shoulder width on westbound C-470 between approximate stations 1051+00 to 1075+00, near Broadway.	Reduced inside shoulder width of 4' for approximately 2,400 feet.
DE-05	Inside Shoulder Width	Inside shoulder width for 6 lane freeway is 10'. For managed lane facilities, the desirable inside shoulder width is 10'.	Reduced inside shoulder width on westbound C-470 between approximate stations 1130+85 to 1155+60, near University Boulevard.	Reduced inside shoulder width of 4' for approximately 2,474 feet.
DE-06	Inside Shoulder Width	Inside shoulder width for 6 lane freeway is 10'. For managed lane facilities, the desirable inside shoulder width is 10'.	Reduced inside shoulder width on westbound C-470 at approximate stations 1190+00 to 1262+74, between University Boulevard and Quebec Street.	Reduced inside shoulder width of 4' for approximately 7,474 feet.
DE-07	Inside Shoulder Width	Inside shoulder width for 6 lane freeway is 10'. For managed lane facilities, the desirable inside shoulder width is 10'.	Reduced inside shoulder width on westbound C-470 at approximate stations 1376+57 to 1407+05, between I-25 and Yosemite Street.	Reduced inside shoulder width of 4' for approximately 3,048 feet.
DE-08	Inside Shoulder Width	Inside shoulder width for 6 lane freeway is 10'. For managed lane facilities, the desirable inside shoulder width is 10'.	Reduced inside shoulder width on eastbound C-470 at approximate stations 992+17 to 1013+00, near Lucent Boulevard.	Reduced inside shoulder width of 4' for approximately 2,084 feet.
DE-09	Inside Shoulder Width	Inside shoulder width for 6 lane freeway is 10'. For managed lane facilities, the desirable inside shoulder width is 10'.	Reduced inside shoulder width on eastbound C-470 at approximate stations 1137+41 to 1168+09, near University Boulevard.	Reduced inside should width of 4' for approximately 3,068 feet.
DE-10	Inside Shoulder Width	Inside shoulder width for 6 lane freeway is 10'. For managed lane facilities, the desirable inside shoulder width is 10'.	Reduced inside shoulder width on eastbound C-470 at approximate stations 1235+00 to 1288+60, between Colorado Boulevard and Quebec Street.	Reduced inside shoulder width of 4' for approximately 5,360 feet.
DE-11	Stopping Sight Distance	Standard Stopping Sight Distance for 70 mph design speed is 730 feet.	Reduced stopping sight distance on westbound C-470 at Curve 3 between approximate stations 822+17 to 837+24, with a 12-foot inside shoulder.	Reduced stopping sight distance to 602 feet, meeting 60 mph design speed.

DE-12	Stopping Sight Distance	Standard Stopping Sight Distance for 70 mph design speed is 730 feet.	Reduced stopping sight distance on eastbound C-470 at Curve 4 between approximate stations 886+82 to 904+29, with a 10-foot outside shoulder.	Reduced stopping sight distance to 555 feet, meeting 55 mph design speed.
DE-13	Stopping Sight Distance	Standard Stopping Sight Distance for 70 mph design speed is 730 feet.	Reduced stopping sight distance on westbound C-470 at Curve 8 between approximate stations 1012+20 to 1042+57, with a 10-foot outside shoulder.	Reduced stopping sight distance to 598 feet, meeting 60 mph design speed.
DE-14	Stopping Sight Distance	Standard Stopping Sight Distance for 70 mph design speed is 730 feet.	Reduced stopping sight distance on eastbound C-470 at Curve 11 between approximate stations 1168+09 to 1189+82, with a 10-foot outside shoulder.	Reduced stopping sight distance to 716 feet, meeting 65 mph design speed.
DE-15	Stopping Sight Distance	Standard Stopping Sight Distance for 70 mph design speed is 730 feet.	Reduced stopping sight distance on eastbound C-470 at Curve 15 between approximate stations 1336+79 to 1375+78, with a 10-foot outside shoulder.	Reduced stopping sight distance to 692 feet, meeting 65 mph design speed.
DE-16	Stopping Sight Distance	Standard Stopping Sight Distance for 70 mph design speed is 730 feet.	Reduced stopping sight distance on eastbound C-470 at Curve 16 between approximate stations 1379+71 to 1408+27, with a 12-foot inside shoulder.	Reduced stopping sight distance to 689 feet, meeting 65 mph design speed.

13.2.11.2 Design Exception Process

Design Exceptions in addition to those identified herein shall be subject to the Approval of CDOT. If determined to be necessary by CDOT, Design Exceptions may be subject to the Approval of FHWA.

The Contractor shall comply with the following requirements when requesting a Design Exception:

1. The Contractor shall submit Design Exception requests in the form of a letter addressed to the CDOT Project Director for Approval prior to issuance Pre-Release for Construction (RFC) Review Documents.
2. The Design Exception request shall consist of the following items:

   A. A letter identifying the exception(s) by number, Project number, location, and status (new submittal, resubmittal, etc.)

   B. A completed CDOT Form 464a

   C. Supporting documentation indicating the justification for the Design Exception. Justification shall address the following items:

      (1) Site conditions of the exception.
      (2) Compelling reason for the exception, including which standard is not being met. If the exception affects any other standards, state what will be done to mitigate the effects of the exception.
      (3) Effects of the exception on safety and operation of the facility.
      (4) Previous crash history near the location of the exception.
      (5) Calculations estimating the cost of attaining the design standard and costs of exception as proposed.
      (6) Effect on scenic, historical, or other environmental features.

   D. Plan and profile drawings depicting the exception.

13.2.12 Safety Edge

The Contractor's design shall include Safety Edges, as defined in Book 2, Section 20 and as shown in the plans in the Reference Documents. Safety Edges shall be required on all mainline C-470 pavement and ramp pavement. Safety Edges shall not be required in front of guardrail, adjacent to median barrier, mainline C-470 abutting ramp pavement, or on roadways that require curb and gutter.

13.3 Construction Requirements

13.3.1 Concrete Slope and Ditch Paving

Concrete slope and ditch paving shall be used in medians with widths less than 24 feet.

13.3.2 Toll Points

Toll Point will be required at the following locations. See Book 2, Chapter 19 ITS-Tolling for more information.

13.3.3 Fencing

13.3.3.1 Temporary Fencing

Installation of temporary fencing will be required according to ROW acquisition agreements to protect adjacent private property. In remaining areas, temporary fencing should be considered to control construction operations and avoid impacts beyond ROW limits. Temporary fence shall be placed as may be required in any other section of the Contract.

13.3.3.2 Permanent Fencing

Provide permanent right of way fencing of types and at locations in Table 13.3-1. In remaining areas, if a permanent fence is impacted due to Construction, it shall be replaced per CDOT Standard M-607-1 or M-607-2, whichever is applicable.

Table 13.3-1 RIGHT OF WAY FENCING LOCATIONS		
Location* * Station locations are approximate	**Type**	**Remarks**
Access control between Stations 1385+00 – 1400+00 RT	60" Chain Link	Per CDOT Standard M-607-2
Access control between Stations 1390+00 – 1395+00 LT	60" Chain Link	Per CDOT Standard M-607-2
Deer Fence between Stations 895+00 - 915+00 LT	Deer Fence	Per CDOT Standard M-607-4
Deer Fence between Stations 880+00 – 917+00 RT	Deer Fence	Per CDOT Standard M-607-4
Right-of-Way Fence Impacted by Construction	Combination Wire with Wooden Posts	Per CDOT Standard M-607-1

13.3.3.3 Gates

Provide gates in fences at locations, width and type as specified by requirements of the Contract or other maintaining entities for maintenance access, including CDOT. Field locations of gates shall be shown in the plans and approved by CDOT.

13.4 Deliverables

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

Deliverable	Review, Acceptance, or Approval	Schedule
Design Exceptions (if applicable)	Approval	Prior to issuance of Pre-Release for Construction (RFC) Review Documents
Field Locations of fencing gates	Approval	Prior to Issuance of Pre-Released for Construction (RFC) Review Documents

13.5 Project Special Provisions

The following specifications modify and take precedence over the Standard Specifications.

13.5.1 Tensioned Cable Barrier (TL-3)

Section 606 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION
This work consists of the installation of Tensioned Cable Barrier at locations shown on the plans.

MATERIALS

The tensioned cable barrier system shall meet NCHRP Report 350 (only applicable for those systems developed prior to 2011) or MASH (acceptable for all systems), Test Level 3 (TL-3), and shall be one of the following:

(1) Brifen Wire Rope Safety Fence (Brifen WRSF) supplied by Brifen USA Inc., 12501 N. Sante Fe Ave., Oklahoma City, OK 73114, Phone: (405) 751-8062, Fax: (405) 751-8338.
(2) Trinity Cable Safety System (Trinity CASS) supplied by Trinity Industries, Inc., 2525 Stemmons Freeway, Dallas, TX 75207, Phone: (800) 772-7976, Fax: (801) 292-9138.
(3) Safence Cable Barrier System (Safence) supplied by Gregory Industries, 4100 13th St., SW, Canton, Ohio, 44710, Phone 330-477-4800, Fax: 330-477-0626.
(4) Gibraltar Cable Barrier Systems (Gibraltar) supplied by Gibraltar Cable Barrier Systems, L.P., 4303 Innovation Loop, Marble Falls, TX, 78654, Phone 800-495-8957, Fax: 830-798-5445

The wire cable shall be pre-stretched during manufacture in accordance with the manufacturer's specifications. All posts shall be socketed posts. Concrete for posts and anchorages shall be Class B. End Anchorages (Tensioned Cable Barrier) shall meet NCHRP 350 (only applicable for end anchorages developed prior to 2011) or MASH (acceptable for all end anchorages), TL-3.

CONSTRUCTION REQUIREMENTS

Tensioned Cable Barrier shall be installed in accordance with the details shown on the plans and in accordance with manufacturer's recommendations. The post spacing for the system used shall be no greater than that tested in accordance with NCHRP 350 or MASH (per test utilized) for an impact deflection not to exceed nine feet and must be approved by the FHWA. The maximum post spacing shall be 20 feet.

The Contractor shall arrange for a qualified representative from the cable barrier manufacturer to be on site for the following:

(1) The Contractor shall be adequately trained by the manufacturer's representative to ensure proper installation of the Cable Barrier.
(2) The Manufacturer's representative shall check installation and tensioning after completion.

The Contractor shall obtain documentation from the manufacturer confirming the most recent detailed drawings are provided for the materials to be installed, and that these materials conform to the requirements of the NCHRP 350 or MASH (per test utilized), TL-3. Three weeks prior to start of work, the Contractor shall submit three copies of the submittal drawings and specifications to the Engineer. Work shall not begin until approval of these drawings has been received from the Engineer.

Installation of the cable barrier shall be performed in the presence of the Engineer and a qualified representative of the manufacturer.

The Contractor shall obtain a signed statement from the manufacturer's representative confirming that the cable barrier has been installed correctly and is operational.

Sections of wire cable shall be connected using turnbuckles, with thread connector swaged on the cable. Concrete foundations for end anchorages and line posts shall be constructed with appropriate rebar based on the size of the foundations.

The Contractor shall conduct a soil survey based on at least one test boring every mile and at anchor sites to identify the soil type, classification, and load bearing capacity. The Contractor shall submit the results of the soil survey to the manufacturer so that adjustments can be made to the size or type of footing used. A copy of this survey shall also be submitted to the Engineer for the project records.

The minimum concrete post footing size shall be 14 inches in diameter and 3 feet in depth.

The minimum concrete anchor footing shape may vary according to the manufacturer's recommendations but shall contain at least two cubic yards of concrete per anchor for systems with a single anchor for all cables. For systems having a separate anchor for each cable the footing shall contain at least one half cubic yard of concrete.

The Contractor shall install larger post and anchor footings than the minimum when soil conditions warrant. All size footings shall be constructed using Concrete Class B.

The Contractor shall maintain the cable barrier until CDOT Final Acceptance upon project completion. Cable barrier tensioning shall be checked within six weeks prior to project Final Acceptance.

Tensioned Cable Barrier and End Anchorage (Tensioned Cable Barrier) spare parts shall be provided and become the property of CDOT Maintenance. Spare parts shall include one complete end anchorage and all supplies needed for repairs for 1500 linear feet of Tensioned Cable Barrier, including, but not limited to: tension meter, standard socketed line posts, transition posts, post caps, excluders, locating pegs, cable clamp and prismatic reflectors. Spare parts shall include a cable spreader for weaved type cable installations. Spare parts shall be delivered to the CDOT maintenance yard at 8800 South Wadsworth Ave, Littleton, CO 80123. The Contractor shall coordinate delivery of the spare parts with CDOT Maintenance personnel at 303-512-5485.

METHOD OF MEASUREMENT

Tensioned Cable Barrier will be measured by the linear foot of barrier that is installed and accepted, excluding end anchorage.

End Anchorage (Tensioned Cable Barrier) will be measured by the actual number of anchorages that are installed and accepted. End Anchorage (Tensioned Cable Barrier) shall include concrete for standard foundation, cables, posts, and all necessary parts and fittings.

13.6 Exhibits

Exhibits are as follows:

A. Roadway Design Criteria Table
B. CDOT Design Exception Variance Request Form

Exhibit A – Roadway Design Criteria

Criteria	C-470 Mainline	C-470 Normal Ramps	Express Lane Ramps	Remarks
Design Criteria & Controls				
Design Speed (mph)	70	50	50	
Posted Speed (mph)	65			
Terrain	Rolling	Rolling	Rolling	
Horizontal Alignment				
e_{MAX}	6%	6%*	6%*	CDOT Roadway Design Guide 8.1.6 *CDOT Preference on ramps.
Axis of Rotation	PGL	HCL	HCL	
Minimum Radius (ft)	2040	833	833	PGDHS Exhibit 3-15 Note: Based on maximum super elevation and design speed
Use of Spirals	Permitted	N/A	N/A	Use spirals is permitted
Vertical Alignment				
Minimum Grade	0.50%	0.50%	0.50%	CDOT Roadway Design Guide Table 3-4
Maximum Grade	4.00%	-5.00% / 5.00%	-5.00% / 5.00%	CDOT Roadway Design Guide 3.3.3 Note: Based on rolling terrain
Minimum K Value, Crest	247	84	84	PGDHS Exhibit 3-72
Minimum K Value, Sag	181	96	96	PGDHS Exhibit 3-75
Sight Distance (SD)				
Stopping SD (ft)	730	425	425	PGDHS Exhibit 3-1, use PGDHS Exhibit 3-2 for SSD on Grades Note: Not adjusted for grade. Allow horizontal sight distance across barriers. Use 3d graphical solutions for areas with vertical curvature. Glare screen not allowed.
Decision SD (ft)	1445	890	890	PGDHS Exhibit 3-3 Note: Applies to express lane entrances and critical gores (Maneuver D)
Vertical Clearance				
Underpass (ft)	16'-6"	16'-6"	16'-6"	CDOT Roadway Design Guide Table 3-3
Overhead Sign Structures (ft)	18'-0"	18'-0"	18'-0"	CDOT Roadway Design Guide Table 3-3
Underpass at Rail Roads	23'-6"	23'-6"	23'-6"	CDOT Roadway Design Guide Table 3-3
C-470 Overpass Local Streets and Collectors (ft)	14'-6"	14'-6"	14'-6"	CDOT Roadway Design Guide Table 3-3 (, Erickson Blvd)
C-470 Overpass Arterials and Freeways (ft)	16'-6"	16'-6"	16'-6"	CDOT Roadway Design Guide Table 3-3 (Wadsworth Blvd, Broadway, University Blvd)
Cross Section				

Lane Width (ft)	12	15 - Single Lane / 12' Two or More Lanes	15 - Single Lane / 12' Two or More Lanes	CDOT Roadway Design Guide 8.1.4, Figure 4-3
Inside Shoulder (ft)	12*	4'	4'	CDOT Roadway Design Guide 8.1.4, Figure 4-3 *4' Through Ingress/Egress zones (see design exception)
Outside Shoulder (ft)	10	6' for Single Lane / 8' for Two or More Lanes	6' for Single Lane / 8' for Two or More Lanes	CDOT Roadway Design Guide 8.1.4, Figure 4-3
HOV Buffer	4			NCHRP 414
Normal Cross-Slope	2%	2%	2%	CDOT Roadway Design Guide 8.1.4
Clear Zone (ft)	34	18	18	
Design Vehicle	WB-67	WB-67	WB-67	
Ramp Terminals				
Acceleration Length (ft)	Varies	Varies	Varies	PGDHS Exhibit 10-70
Deceleration Length (ft)	Varies	Varies	Varies	PDGHS Exhibit 10-73
Transition Taper Rate (ft)	70:1	50:1	50:1	CDOT Roadway Design Guide 10.5.8 Note: For through lane drops
Redirect Taper Rate	70:1	50:1	50:1	Note: For lane shifts
Entrance Ramp Type	N/A	Parallel	Parallel	Figure 10-13 of CDOT Roadway Design Guide 2005
Exit Ramp Type	N/A	Parallel	Parallel	Figure 10-18 of CDOT Roadway Design Guide 2005

CDOT Roadway Design Guide = Colorado Department of Transportation Roadway Design Guide (2005)
PGDHS = A Policy on Geometric Design of Highways and Streets (2004)
NCHRP 414 = National Cooperative Highway Research Program, Report 414 (1998)

Exhibit B – CDOT Design Exception Variance Request Form

COLORADO DEPARTMENT OF TRANSPORTATION
DESIGN EXCEPTION VARIANCE REQUEST

TEA-21 program ☐ NHS ☐ STP | Project Code

Project name | Date | Project Number

Type (check all that are applicable) | Revised | Region

☐ New construction ☐ Restoration ☐ Resurfacing ☐ Rehabilitation ☐ _____
☐ Reconstruction ☐ Safety ☐ Enhancement ☐ _____ ☐ _____

Part 1 – Complete A through G for all projects (if 3R type or Safety type project, show comfort speed: _____ mph or ☐ if shown on CDOT Form 463a).

A. Short project description (☐ see CDOT Form 463 for more detailed description)

☐ NHS standards apply
☐ 3R standards apply
☐ State standards apply
☐ _____

B. Description of standard(s) reduced

PS&E approved by
☐ CDOT
☐ FHWA

C. Rational need for exception(s)

Does this exception affect any existing potential hazards? ☐ (If so, describe hazard and rationale for retaining above.)

D. Mitigation measures proposed (include safety discussion)

E. Description of adjoining sections: (☐ see CDOT Form 463a)
Other:

☐ same as existing project
☐ same as proposed project

F. Accident data Source:

Most recent statewide accident rate (calendar year) for this functional class / facility:
a) _____ b) _____
Latest accident rate for this highway (usually 3 years): _____
a) _____ b) _____

G. Cost

Estimated item cost if built to full standard $ _____
Estimated cost of exception item, as proposed $ _____
± difference in cost: _____ $ _____

H. Other (as needed)

Optional: See _____
for traffic counts and/or additional speed data.

Part 2 – Appropriate signatures required.

A. Submitted by (Project Manager)	Date	Approved by (Program Engineer)	Date

Required for Federal-oversight projects only

B. ☐ Not approved or ☐ approved with conditions

Condition(s) / comment(s)

Approved by (FHWA Division Administrator)	Date

Distribution:
Region _____ Project file
Region _____ Project Manager
Region _____ Program Engineer
HQ _____ Records Center, Project file
FHWA, if applicable

Instructions:
Refer to *The Roadside Design Manual*, Sections 1103.7& 1103.8 for 3R projects
Refer to P.D. 548.1 if project is resurfacing or safety type

CDOT Form #464a 6/01

14.0 SIGNING, PAVEMENT MARKING, SIGNALIZATION AND LIGHTING INFRASTRUCTURE

The Contractor shall provide temporary and new permanent signing, traffic signalization, and lighting for the Project. The Contractor shall provide permanent pavement markings for the Project. The Contractor shall provide construction pavement markings that comply with the requirements in Section 16.

The Contractor shall be responsible for the design and installation of the Project permanent signing, pavement marking, traffic signalization, and lighting elements within the limits of the Project and comply with the requirements of this Section 14.

At this time there is no new temporary or permanent intersection traffic signalization identified. Temporary and/or permanent ramp metering signal technical requirements are discussed in Section 19, ITS.

14.1 Design Requirements

The Contractor shall prepare signing, pavement marking, and lighting designs and plans for all areas on the Project in accordance with the requirements of the following sections. These plans shall be a component of all Released for Construction Documents where any signing, pavement marking, or lighting element is required for the Work. No material, part, or attachment of any equipment shall be substituted or applied contrary to the manufacturer's recommendations and standard practices.

The Contractor shall provide permanent signing, pavement marking, delineation, and other traffic control devices that facilitate safe flow of traffic through the completed Project elements and that accommodates future phases of the Project (subsequent phases and any Additional Requested Elements [AREs] not included in the Basic Configuration).

ARE #1: Extending the proposed eastbound ETL from just west of the Platte River Bridge to Wadsworth will require additional permanent signing, pavement marking and lighting that is not part of the Basic Configuration.

The Contractor shall provide express lane signing, striping and pavement messages in accordance with Section 19, ITS

The electrical designs shall include the electrical and power requirements for the Intelligent Transportation Systems (ITS) as described in Book 2, Section 19, ITS. The Contractor shall coordinate with Xcel Energy to determine electric power requirements for the Project and to develop the Project lighting design and construction requirements. The lighting, ITS, and ETC equipment shall each be on separate circuits. The ITS and ETC equipment can be on the same meter, with the lighting on a separate meter (for billing purposes).

The Contractor shall obtain approval of the power service design from the power service provider and coordinate and meet all requirements as specified by the power service provider

for the complete and operational power service to all required locations. All power connections to devices shall include a quick-disconnect.

The Contractor shall be responsible for the coordination of power source Work to be performed by Xcel Energy. The Contractor shall contact the Xcel Energy Builder's Call Line at 1-800-628-2121 to request, and process to completion, the required coordination to establish the power sources for all Roadway and Street lighting. The Contractor shall perform all Work necessary to maintain existing or establish new power sources for and lighting. West of Quebec the Contractor will be responsible for installing the lighting meter(s) for the Project. All cost charges from the power service provider, and all necessary Materials, including meter (if required), labor, and coordination required to maintain existing or establish new power sources shall be included in the Work.

The Contractor shall design and construct signing, pavement marking, and lighting elements in accordance with the requirements of the standards listed in Table 14.1-1 as appropriate for the jurisdictional ownership, oversight and approval of the Work.

Table 14.1-1
STANDARDS

	Author	Title
1	CDOT	Special Provisions included in Section 14
2	CDOT	*Standard Specifications for Road and Bridge Construction Section 613*
3	Xcel Energy	Xcel Energy Xcel Outdoor Lighting Manual, January 2014
4	CDOT	*Sign Design Manual* – March 31, 2015
5	CDOT	*M&S Standards (Latest Edition)*
5	FHWA	*Manual on Uniform Traffic Control Devices* (Latest Edition)
6	FHWA	*Standard Highway Signs – 2004 Edition*
7	FHWA	*Standard Highway Signs – 2012 Supplement*
8	AASHTO	*A Policy on Geometric Design of Highways and Streets*
9	AASHTO	*Roadside Design Guide*
10	AASHTO	*Standard Specifications for Highway Bridges*, 17th Edition
11	Local Jurisdiction	*Design Standards, Details, and Specifications*
12	CDOT	*CDOT Lighting Design Guide-2006*

14.1.1 Permanent Signing

14.1.1.1 Signing Design

The Contractor shall prepare signing designs and plans for the Project area. These plans shall include all necessary guide, warning, supplemental, and regulatory signs, and additions, removals, or modifications to existing signs and appurtenances. Plans shall also include a preliminary layout of signs, which will be required for future phases of the Project and that may affect placement and configuration of signs placed as a part of the Basic Configuration. In addition a continuous scroll plot shall be prepared covering the entire project area.

Signing design shall comply with the requirements of the most current publications of the CDOT *Standard Specifications for Road and Bridge Construction*, *M & S Standard Plans*, and *Sign Design Manual*; and the FHWA *Manual for Uniform Traffic Control Devices* (MUTCD) as modified by the Colorado Supplement. The requirements of the MUTCD shall include both the standard requirements and the guidance recommendations of the manual. The design and plans shall address modifications to permanent signing inside and outside the Project that is rendered inaccurate, ineffective, confusing or unnecessary by the Project. Signing plans shall provide layouts showing the locations of ground-mounted and overhead signs, special sign details, and structural and foundation requirements.

Signing design for the intersections and local streets shall comply with the respective local agency signage and pavement marking guidelines of:

- Douglas and Jefferson Counties
- City of Lone Tree
- City of Centennial
- City of Littleton

Contractor will submit signing and striping design plans to respective local agencies for review.

Signing shall be provided on all Bikeway elements or connections in accordance with MUTCD and the AASHTO Guide for the Development of Bicycle Facilities, and shall be subject to review and Acceptance by CDOT.

The Contractor shall submit plans for all Class III, major overhead signs, and regulatory and guide signs to CDOT for Acceptance. These plans shall identify the location and legend for each sign. The Contractor shall submit sign layouts for all special signs of any size to CDOT for Acceptance. All existing non-monotube overhead sign structures shall be replaced with new monotube structures.

Where CDOT sign structure standards cannot be met, provide custom-designed monotube sign structures and foundations for Acceptance from CDOT Staff Bridge. Permanent signage near bridges shall not be hung from or be attached to the face of bridge superstructures. Existing signs attached to bridge superstructures shall be removed and replaced with monotube sign bridges or cantilever structures if signs are to remain.

The Contractor shall mount all overhead signs with a minimum vertical clearance of 18’-0”, measured from the high point on the Roadway surface under the sign panels to the bottom of the VMS, VTMS, or guide sign (whichever is lowest).

Sign lighting and walkways shall not be used on overhead sign structures.

Sign structures shall be designed in accordance with CDOT Standard S-614-50 and S-614-60.

All ground mounted signage, delineators, etc., shall be installed within a full depth PVC sleeve at locations where the device is installed within concrete sidewalk, median cover material, concrete pavement, slope paving, etc.

14.1.1.2 Materials

The Contractor shall use schedule 80 tubular steel posts per CDOT *S-Standard Plans* for all Class I and Class II ground signs. Wood posts for mounting ground signs shall not be used. All delineators shall have metal posts.

All ground signs shall include breakaway devices per CDOT *S-Standard Plans*.

Sign panel materials shall conform to CDOT *Standard Specifications* Section 713. Sheeting shall be Type IV and Type XI as defined in the CDOT Retroreflective Sheeting Materials Guide, and shall conform to Subsections 713.04 and 713.06 when applicable. For all permanent signs, the legend, borders, and background shall be Type XI.

The Contractor may not reuse any existing sign structures. The Contractor may reuse ground signs in good condition and their components with prior Acceptance by CDOT and if they meet all current CDOT and MUTCD standards. Good condition is defined as meets minimum retroreflectivity, as defined in MUTCD 2A.08, only minor abrasions/scratches to the face/reflective materiel, panels that are not too bent, and little to no corrosion and damage to steel components, as observed in it's mounted condition. A sign in good condition must have an expected sign life that is at least two years beyond the planned completion of the project. Any existing signs not meeting MUTCD retro-reflectivity requirements shall be replaced as part of the Project.

14.1.2 Permanent Pavement Marking

14.1.2.1 Pavement Marking Design

The Contractor shall prepare pavement marking designs and plans for roads affected by the construction of the Project. These plans shall include, all striping required for center lines, edge lines, lane lines, gore areas, lane drops, merging lanes, transition lanes, bike lanes, arrows, legends, symbols, object markings, delineation, and other striping, as well as any modifications required for transitions to existing pavement markings.

Pavement marking design for CDOT facilities shall comply with the requirements of the most current publications of the CDOT *Standard Specifications for Road and Bridge Construction* and *M & S Standard Plans*; and the FHWA MUTCD. The requirements of the MUTCD shall include both the standard requirements and the guidance recommendations of the manual.

Striping design for the local streets and intersections shall comply with the respective local agency signage and pavement markings guidelines:

- Douglas and Jefferson Counties
- City of Lone Tree
- City of Centennial
- City of Littleton

The conceptual mainline and other roadway striping as shown in the Reference Documents is for information and reference only.

14.1.2.2 Materials

The Contractor shall use pavement marking Materials specified in Table 14.1-2, and in accordance with CDOT Standard S-627-1 and Standard Specification Sections 627 and 713.

Table 14.1-2
CDOT Region 1 Striping Materials Selection Guide (04-2014)

					Temporary Pavement Marking	PMP (Waterborne) PMP (W) Hi build	627-00011 627-00013	90 SF/G 70 SF/G	Low and Med Volume High Volume	*Under 40 degree: PMP (low Voc) 627-00012 95 SF/G
	Classification	Surface	Lighting	Edge and Center Lines	Channelizers	Lane Lines	Lane Drop Lines	Hatching Lines	Crosswalks and Stop Bars	Words and Symbols
New Pavements	Freeway (Mainline and Ramps)(High Volume]	Asphalt	Continuous	Modified Epoxy	PPPM (Type I)(Inlaid)	PPPM (Type I)(Inlaid)	PPPM (Type I)(Inlaid)	PPPM (Type I)	PPPM (Type I) (XS) or Preformed Thermoplastic	PPPM (Type I) (XS) (Recessed) or Preformed Thermoplastic (Recessed)
			Sporadic or None	Modified Epoxy						
		Concrete	Continuous	Modified Epoxy	PPPM (Type I)(Inlaid)	PPPM (Type II)(Inlaid)	PPPM (Type I)(Inlaid)	PPPM (Type I)	PPPM (Type I) (XS) or Preformed Thermoplastic	PPPM (Type I) (XS) (Recessed) or Preformed Thermoplastic (Recessed)
			Sporadic or None	Modified Epoxy						
	Arterial (ADT >= 10,000) (Med Volume)	Asphalt	Continuous	Modified Epoxy	Modified Epoxy or PPPM (Type I)(Inlaid)	PPPM (Type I)(Inlaid)	PPPM (Type I)(Inlaid)	PPPM (Type I) or Preformed Thermoplastic	PPPM (Type I) (XS) or Preformed Thermoplastic	PPPM (Type I) (XS) (Recessed) or Preformed Thermoplastic (Recessed)
			Sporadic or None	Modified Epoxy	Modified Epoxy or PPPM (Type I)(Inlaid)					
		Concrete	Continuous	Modified Epoxy	Modified Epoxy	PPPM (Type II)(Inlaid)	Tape	PPPM (Type I) or Preformed Thermoplastic	PPPM (Type I) (XS) or Preformed Thermoplastic	PPPM (Type I) (XS) (Recessed) or Preformed Thermoplastic (Recessed)
			Sporadic or None	Modified Epoxy	Modified Epoxy		Tape			
	Arterial (ADT >= 10,000) (Low Volume)	Asphalt	Continuous	Modified Epoxy	Modified Epoxy	PPPM (Type II)	PPPM (Type II)	PPPM (Type I) or Preformed Thermoplastic	PPPM (Type I) (XS) or Preformed Thermoplastic	PPPM (Type I) (XS) (Recessed) or Preformed Thermoplastic (Recessed)
			Sporadic or None							
		Concrete	Continuous							
			Sporadic or None							

	Classification	Surface	Lighting	Edge and Center Lines	Channelizers	Lane Lines	Lane Drop Lines	Hatching Lines	Crosswalks and Stop Bars	Words and Symbols
Existing Pavements	Freeway (Mainline and Ramps)(High Volume]	Asphalt	Continuous	Modified Epoxy	PPPM (Type I)(Inlaid) or Modified Epoxy	PPPM (Type I)(Inlaid)	PPPM (Type I)(Inlaid)	Preformed Thermoplastic	Preformed Thermoplastic (XS) or MMPM	Preformed Thermoplastic (WS) or MMPM
			Sporadic or None	Modified Epoxy						
		Concrete	Continuous	Modified Epoxy	PPPM (Type I)(Inlaid) or Modified Epoxy	PPPM (Type II)(Inlaid)	PPPM (Type I)(Inlaid)	PPPM (Type I) or Preformed Thermoplastic	PPPM (Type I) (XS) or MMPM or Preformed Thermoplastic	PPPM (Type I) (WS) or MMPM or Preformed Thermoplastic
			Sporadic or None	Modified Epoxy						
	Arterial (ADT >= 10,000) (Med Volume)	Asphalt	Continuous	Modified Epoxy	PPPM (Type I)(Inlaid) or Modified Epoxy	PPPM (Type I)(Inlaid)	PPPM (Type I)(Inlaid)	PPPM (Type I) or Preformed Thermoplastic	PPPM (Type I) (XS) or MMPM	Preformed Thermoplastic (WS) or MMPM
			Sporadic or None	Modified Epoxy						
		Concrete	Continuous	Modified Epoxy	Modified Epoxy	PPPM (Type II)(Inlaid)	Tape	PPPM (Type I) or Preformed Thermoplastic	PPPM (Type I) (XS) or MMPM or Preformed Thermoplastic	PPPM (Type I) (WS) or MMPM or Preformed Thermoplastic
			Sporadic or None	Modified Epoxy	Modified Epoxy		Tape			
	Arterial (ADT >= 10,000) (Low Volume)	Asphalt	Continuous	Modified Epoxy	Modified Epoxy	Tape	Tape	Preformed Thermoplastic	PPPM (Type I) (XS) or Preformed Thermoplastic	PPPM (Type I) (WS) or Preformed Thermoplastic
			Sporadic or None							
		Concrete	Continuous					PPPM (Type I)		
			Sporadic or None							

					PPPM: Preformed Plastic Pavement Marking			PTPM: Preformed Plastic Pvmt Marking		
					MMPM: Methyl Methacrylate Pvmt Mkg /GAL			MMPM(Inlaid): Methyl Methacrylate Pvmt Mkg /SF		
	Pay/Item/Application Rate (ITIS):									
	Modified Epoxy	627-0008	80 SF/G	PPPM (Type I)	627-01001	PPPM (Type I) (XS)	627-30329		PTPM (WS)	627-30405
	PPPM (Type I)(Inlaid)	627-01010	N/A	PPPM (Type I) (WS)	627-30324	PTPM	627-00070		PTPM (XS)	627-30410

Striping materials for local facilities shall conform to the respective local agency requirements:

- Douglas and Jefferson Counties
- City of Lone Tree
- City of Centennial
- City of Littleton

The Contractor shall refer to CDOT's Material Striping Chart as shown above for pavement marking materials for C-470, I-25/C-470 ramps and other CDOT designated facilities that are impacted by construction.

14.1.3 Delineators

14.1.3.1 Delineator Design

The Contractor shall prepare a delineator design to be included in the Signage & Pavement Marking Plans. Tubular Flexible Delineators shall be placed at 12' spacing in the buffer zone separating the general purpose lanes and express toll lanes for all buffer zones 4' or greater.

14.1.3.2 Materials

The Tubular Flexible Delineators shall be City Post SM Surface Mount as manufactured by Pexco, Davidson Traffic Control Products, with 36" height, white color, and white 3M Flex Diamond Grade reflective sheeting. The delineators shall be installed in accordance with the manufacturer's specifications. A manufacturer technical representative shall observe the first day of installation and provide any necessary training to the Contactor to address proper installation. The manufacturer technical representative shall furnish a letter documenting the results of the observations, any training and/or corrections made, and state that installation was performed in accordance with the manufacturer's installation specifications.

14.1.4 Lighting

14.1.4.1 Permanent Lighting Design

The Contractor shall prepare lighting designs and plans for the C-470 interchange areas, including ramps, and all existing permanent lighting conditions on roadways impacted by the Project. All permanent lighting within the Project west of Quebec, shall be LED luminaries, east of Quebec shall meet Xcel Energy Standards Lighting designs, and shall be designed and constructed to be consistent with current CDOT guidelines, including guidelines for required lighting values, and Xcel Energy Standards Lighting designs and Plans shall be subject to the review and approval of CDOT and Xcel Energy

Lighting plans shall address both temporary and permanent Work and shall include existing topography, right of way, utilities, drainage facilities, structures, and all other existing and proposed facilities. The plans shall include location and orientation of standards and fixtures, wiring, conduits, pedestals, power sources, and all other lighting components required to construct the lighting on the Project.

Roadway lighting for C-470 shall be provided for the interchange areas,, including ramps, being constructed by the Project and from the outside edges of the roadways, unless otherwise

approved by CDOT. Lighting for ramps shall replace any lighting impacted by the Project, and at a minimum provide partial interchange lighting for all ramp entrances and exits. High-mast lighting will not be allowed west of Quebec. High-mast lighting within the I-25 interchange area shall remain or be reset. The Contractor is allowed to reset LED luminaires west of Quebec. The Contractor is allowed to reset luminaire poles and mast arms, in good condition, with prior Acceptance by CDOT. The Contractor shall provide inspection and a design report for certification that the existing luminaire poles, mast arms, and all structural connections to be re-used are adequate for reuse and can accommodate the required loading. The design report for certification shall be signed and sealed by the Contractors Engineer, and submitted to CDOT for Acceptance. If any structural modifications to existing luminaire poles, mast arms, or structural connections are proposed, shop drawings and calculations shall be submitted to CDOT for Acceptance. The calculations shall be signed and sealed by the Contractor's Professional Engineer.

The Contractor shall submit to CDOT for Acceptance lighting calculations, including voltage-drop calculations for each circuit, showing that the design meets the performance criteria for roadway design to include average, maximum, minimum foot-candles; and average to minimum, and maximum to minimum luminance on the horizontal roadway plane. The lighting design shall include iso-foot-candle curve plots showing foot-candle levels at 1.0, 0.5, 0.2, and 0.1 foot candles. The design and plans shall also include circuit layouts showing underground circuits alongside and under the roadway and through retaining wall and bridge structures.

Lighting on and underneath all bridge structures and within structures for public use facilities, such as sidewalks, bikeways, and trails, within the Project boundaries shall comply with the design criteria for average and minimum luminance for the roadway or pedestrian/bicycle facility. Roadway and pedestrian lighting on bridge structures, west of Quebec, shall comply with the requirements of the CDOT Lighting Design Guide and east of Quebec the Xcel Energy Xcel Outdoor Lighting Manual.

14.1.4.2 Permanent Lighting Materials

The Contractor shall use lighting Equipment for all permanent installations on C-470 including ramps as specified in the CDOT *Lighting Design Guide*, *M&S Standards* and Xcel Energy *Standards Specifications.*

CDOT is responsible for lighting maintenance for the Project west of Quebec and Xcel Energy is responsible for lighting maintenance for the Project east of Quebec. The Contractor shall submit the Materials lists for the proposed lighting, including under deck lighting for review and Acceptance by Xcel Energy prior to ordering material. The Contractor shall contact the Xcel Energy Builder's Call Line at 1-800-628-2121 to request, and process to completion, the required coordination to Review and approve the lighting Equipment. All cost charges from Xcel Energy for review and Acceptance shall be included in the Work. All lighting Materials for C-470 and ramps must be approved by CDOT and meet Xcel Energy's Approved Materials List (APL).

14.1.4.3 Temporary Lighting

The Contractor shall provide installation, maintenance, and removal of all temporary lighting devices. The Contractor shall maintain temporary lighting at a level equivalent to existing

lighting provided within the Project Limits, including C-470 and I-25 mainlines, ramp gores, ramp intersections and local streets.

14.2 Construction Requirements

14.2.1 Permanent Signing

The Contractor shall remove and dispose of all existing sign structures, ground-mounted signs, and delineators within the Project area that conflict with project modifications or do not meet the specifications contained herein, and they shall become the property of the Contractor. See Section 16.3.1.1 (Construction Signing) for additional construction signing requirements.

14.2.2 Permanent Pavement Marking

New PCCP shall be sandblasted prior to placement of any primer or pavement-marking material.

14.2.4 Permanent Lighting

Xcel Energy will remove the existing lighting as required within the Project area only for lighting that is owned by Xcel Energy. The Contractor shall be responsible for the coordination of lighting removal and lighting relocation Work to be performed by Xcel Energy. The Contractor shall contact the Xcel Energy Builder's Call Line at 1-800-628-2121 to request, and process to completion, the required coordination for Xcel Energy lighting removal or lighting relocation Work. The Contractor shall remove the existing lighting as required within the Project area that is not owned by Xcel Energy, and shall become the property of the Contractor.

14.3 Project Special Provisions

The following specifications modify and take precedence over the Standard Specifications.

14.3.1 REVISION OF SECTION 627 AND 713

MODIFIED EPOXY PAVEMENT MARKING

Sections 627 and 713 of the Standard Specifications are hereby revised for this project as follows:

Section 627.05 shall include the following:

Modified Epoxy Pavement Marking shall conform to subsection 713.17.

Subsection 627.13 shall include the following:

Pay Item	**Pay Unit**
Modified Epoxy Pavement Marking	Gallon

In subsection 713.17, delete (f) and (k), and replace with the following:

(f) *Color.* The epoxy material, without drop-on beads, shall correspond following requirements:

White – Federal Standard No. 595B-17925. The Yellowness Index (YI) of white shall not exceed 8.0 per ASTM E-313-10 initially.

After 72 QUV exposure per ASTM G-154 with a UVA-340 Lamp at an irradiance of 0.89 W/m2/nm with alternating cycles of 4 hours U.V @ 140º F, and 4 hours humidity @ 122º F the YI shall not exceed 15 when measured per ASTM E-313.

The YI, after 500-hour QUV testing as above, shall not exceed 27.

Yellow – Materials for pavement markings shall meet the initial daytime chromaticity that fall within the box created by the following corner points:

Initial Daytime Chromaticity Coordinates (Corner Points)

	1	**2**	**3**	**4**
x	0.530	0.510	0.455	0.472
y	0.456	0.485	0.444	0.400

After 72-hour QUV exposure per ASTM G-154 with a UVA-340 Lamp at an irradiance of 0.89 W/m2/nm with alternating cycles of 4 hours U.V @ 140º F, and 4 hours humidity @ 122º F the Yellow shall fall within the initial chromaticity coordinates stated above.

Abrasion Resistance. The abrasion resistance shall be evaluated on Taber Abrader with a 1000 gram load and CS-17 wheels. The duration of the test shall be 1000 cycles. The wear index shall be calculated based on ASTM test method C-501 and the wear index for the catalyzed material shall not be more than 60. The tests shall be run on cured samples of material which have been applied at film thickness of 15 ± ½ mils to code S-16 stainless steel plates. The samples shall be allowed to cure at 75 ± 2 °F for a minimum of 72 hours prior to performing the indicated tests.

14.4 Deliverables

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

Deliverable	Review, Acceptance, or Approval	Schedule
Preliminary Signage & Pavement Marking Plans	Review	As Part of The Preliminary Design Plans (30%) Submittal
Signage & Pavement Marking Plans	Review/Acceptance	As Part of The Pre-RFC Review Documents and Final RFC Documents Submittals
Class III, major overhead signs, and regulatory and guide signs plan including signing scroll plot	Review/Acceptance	Prior to fabrication of overhead sign panels and As Part of The Pre-RFC Review Documents and Final RFC Documents Submittals
Sign layouts for all special signs of any size	Review/Acceptance	As Part of The Pre-RFC Review Documents and Final RFC Documents Submittals
Custom-designed monotube sign structure and foundation plans	Review/Acceptance	As Part of The Pre-RFC Review Documents and Final RFC Documents Submittals
Median butterfly sign structure and foundation plans	Review/Acceptance	As Part of The Pre-RFC Review Documents and Final RFC Documents Submittals
Preliminary Lighting Plans	Review	As Part of The Preliminary Design Plans (30%) Submittal
All permanent lighting plans	Review/Acceptance	As Part of The Pre-RFC Review Documents and Final RFC Documents Submittals
Lighting and electrical design calculations	Review/Acceptance	As Part of The Pre-RFC Review Documents and Final RFC Documents Submittals
Materials lists for the proposed lighting, including underdeck lighting	Acceptance	As Part of The Pre-RFC Review Documents and Final RFC Documents Submittals and Prior to Ordering Material
Inspection and design report certification for reuse of existing luminaire poles, mast arms, and all structural connections	Review/Acceptance	As Part of The Preliminary Design Plans (30%), Pre-RFC Review Documents, and Final RFC Documents Submittals
Reuse of existing ground signs	Review/Acceptance	As Part of The Pre-RFC Review Documents and Final RFC Documents Submittals

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 highways and bridges. 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.

Refer to Table 15.0.1 and Section 15 for the work required at the existing bridges on the project.

TABLE 15.0.1
ACTION FOR EXISTING BRIDGE STRUCTURES

Structure No.	Structure Description	Work
F-16-HV & F-16-HW	C470 over South Platte River	Removal and reconstruction
F-16-KL & F-16-KM	C470 over S. Erickson Blvd.	Widening, replace asphalt, waterproofing membrane, approach slab, and bridge deck rehabilitation as needed
F-17-HW & F-17-HX	C470 over S. Broadway	Widening, replace asphalt, waterproofing membrane, approach slab, and bridge deck rehabilitation as needed
F-17-HP & F-17-HQ	C470 over S. University Blvd.	Widening, replace asphalt, waterproofing membrane, approach slab, and bridge deck rehabilitation as needed
F-17-HS & F-17-HT	C470 over Big Dry Creek	Widening, replace asphalt, waterproofing membrane, approach slab, and bridge deck rehabilitation as needed
F-17-HN & F-17-HO	C470 over Acres Green Drive	Widening, replace asphalt, waterproofing membrane, approach slab, and bridge deck rehabilitation as needed
F-17-HL & F-17-HM	C470 over S. Yosemite St.	Widening, replace asphalt, waterproofing membrane, approach slab, and bridge deck rehabilitation as needed
F-17-IE (no general layout sheet provided in Reference documents)	Ramps A and F over SW Ramp (County Line Rd to SB I-25)	Widening, replace asphalt, waterproofing membrane, approach slab, and bridge deck rehabilitation as needed

New Structures shall be constructed for the Project in the I-25/C-470 Interchange at the following locations (no general layout sheets provided in Reference documents):

- SB I-25 to WB C470 Ramp over WB E470 to WB C470 Ramp (one bridge for general purpose lanes, and one bridge for direct connect)
- NB I25 to WB C470 Ramp over SB I25 to WB C470 and WB E470 to WB C470 Ramps

Extension of existing concrete box culverts are anticipated at the following locations:

- Structure F-16-BP (Minor) at milepoint 17.540
- Structure F-17-IC at milepoint 25.053

Repair the cracks in the slab and walls of the existing concrete box culverts listed above. Crack widths less than or equal to 0.006 inches shall be sealed with Concrete Sealer as described in CDOT Standard Construction Specifications. Crack widths greater than 0.006 inches shall be repaired using an approved epoxy injection.

Resetting of Major Sign Structures shall not be allowed.

New concrete box culverts are required for the C470 trail under the existing WB C470 off-ramp and the WB C470 on-ramp at Quebec Street. Lighting for trail underpass shall be included and designed in accordance with Section 14.0 Signing, Pavement Marking and Lighting.

No Project Structure shall preclude anything required as part of the 2015 C470 Revised Environmental Assessment as further defined in Section 1.

Contractor shall comply with all Third Party Agreements included in Book 2, Section 6. For any work required at Structure F-17-IE, Contractor shall also comply with the RTD Light Rail Design Criteria referenced in Book 3, Section 15.

The Contractor shall obtain structure numbers for all new structures from CDOT Staff Bridge during preliminary design. If any additional major structures are required during the final design process, the Contractor shall obtain additional Structure numbers from CDOT Staff Bridge.

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.

15.1.2 Software

The following software shall be used to load rate Structures on this Project:

1. AASHTOWare Bridge Rating (BrR)
2. BRASS-CULVERT, Culvert Load Rating 15.2 Design Requirements
3. If a Bridge type is selected that cannot be rated using the above software packages, the Contractor shall submit to CDOT the proposed rating software for Approval.

15.2 Design and Construction Requirements

15.2.1 Materials

15.2.1.1 Concrete

Cement types recommended in the Foundation Design Report shall be used for cast-in-place concrete in contact with soils. High sulfate content soils shall require Type V cement. Type III cement may be used for precast concrete. Class D concrete shall be used for noise wall panels, abutments, piers and walls. Class BZ concrete shall be used for drilled caissons and filling post holes. Class B concrete shall be used for slope paving. Class D or H concrete shall be used for all conventionally reinforced Bridge decks, diaphragms, approach slabs, and Bridge rails with one exception. One of the new bridge decks at C470/South Platte River or a single ramp bridge in the I-25 Interchange shall use Class G Concrete as described in the Project Special Provisions. Class D, PS, or S40 concrete shall be used for all pretensioned or post-tensioned concrete. Structural Concrete used on this project shall conform to CDOT Standard Specifications, Section 15 – Structures, and Section 20 – Modifications to Standard Specifications The proposed concrete mix design and procedures shall meet the above requirements and shall be submitted for Acceptance by CDOT at least 3 weeks prior to the anticipated concrete placement date.

The use of lightweight concrete will not be allowed.

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

Maximum design concrete strengths used for design shall be:

Cast-in-place: f'c = 6.0 ksi

Precast: f'c = 10.0 ksi

15.2.1.2 Pretensioning Steel

The minimum center-to-center strand spacing shall be 1 ¾ inches for 0.5 inch diameter strand and 2 inches for 0.6 inch diameter strand. Strands shall conform to ASTM A 416 (AASHTO M 203), Grade 270, Low Relaxation Strands.

15.2.1.3 Post-Tensioning Steel Systems

The Contractor shall provide corrosion protection for the strands consisting of grout filled galvanized or non-metallic ducts. Grout shall meet the requirements of Section 618 of the Standard Specifications. Installers of prestressing, post-tensioning systems shall be Post-Tensioning Institute (PTI) certified. The diameter for strands shall be 0.6 inches or 0.5 inches. Strands shall conform to ASTM A 416 (AASHTO M 203), Grade 270, Low Relaxation Strands.

15.2.1.4 Reinforcing Steel

The use of epoxy coated reinforcing steel for all Bridges, walls, tunnels, noise walls, and box culverts shall be as defined in Table 1, subsection no. 8.1 of the CDOT Bridge Design Manual and CDOT Bridge Technical Memorandums. The design category for anticipated level of de-icing salt application shall be "High". Abutments and pier columns exposed to splash from the adjacent Roadway shall use epoxy coated reinforcing steel. The splash zone is defined as anything within 10 feet horizontally of the outside edge of a roadway shoulder. All reinforcing

steel shall conform to the requirements of the Standard Specifications and consist of deformed bars conforming to ASTM A 615 except reinforcing to be welded shall conform to ASTM A 706. Epoxy coated reinforcing shall also conform to ASTM D 3963.

15.2.1.5 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, which 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 painted per Section 509 of the Standard Specifications and the Project architectural requirements. Weathering steel may be used if allowed by the Project Aesthetic Plan included in Book 3.

15.2.2 Design Parameters

15.2.2.1 General

The Contractor shall complete the design in accordance with AASHTO Load Resistance Factor Design (LRFD) Bridge Design Specifications, Seventh Edition, with current interim revisions (hereinafter referred to as AASHTO LRFD Bridge Design Specifications), except as otherwise noted in this Section 15. All design calculations and plans shall be performed in English (Standard) units. Horizontally curved steel Bridges shall be designed in accordance with the AASHTO Guide Specifications for Horizontally Curved Steel Girder Highway Bridges.

Bridge superstructure types that would require temporary falsework or shoring for construction are allowed and shall meet all required vertical and horizontal clearances for both temporary conditions (construction) and final conditions. All falsework shall be designed in accordance with the AASHTO Guide Design Specifications for Bridge Temporary Works, First Edition with current interim revisions. See Section 15.2.11.5 for additional requirements.

All grade separated crossing of railroad facilities shall be designed and constructed in accordance with the current BNSF Railway – Union Pacific Railroad Guidelines for Railroad Grade Separation Projects and the American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.

For Bridges, structural concrete coating (or paint for steel structures) shall be applied to surfaces for each particular Structure in accordance with the Project Aesthetics Plan in Book 3. All other visible, exposed, and accessible concrete surfaces shall have a surface treatment of structural concrete coating. Retaining walls, noise walls, and slope paving shall receive structural concrete coating unless noted otherwise. The existing slope paving, bridge piers and abutments of widened bridges shall also be coated to provide a consistent color and texture between the existing and widened portions of the bridge.

The bridges shown in Table 15.0.1 that require widening shall satisfy the minimum vertical clearance requirements shown in Section 15.2.3.1 Geometry. At some locations, the new girder depth for the widening must be shallower than the existing girders in order to satisfy the vertical clearance requirement. The Contractor must obtain approval from CDOT to use girders for bridge widening that are shallower than the existing bridge girders.

15.2.2.2 Loads and Forces

The Contractor shall design all Structures, except as otherwise noted in this Section 15, for loads and forces in accordance with the AASHTO LRFD Bridge Design Specifications, or as stated herein.

Architectural elements and components to be constructed as part of Bridges, retaining walls, and noise walls shall be designed using the International Building Code if the design of these elements is not covered by an appropriate AASHTO specification.

15.2.2.2.1 Live Loads

The Contractor shall design new Highway Bridges, box culverts, tunnels, retaining walls and Highway Bridge widenings using the live loads defined in the AASHTO LRFD Bridge Design Specifications. All Highway Bridges shall also be designed for the Colorado Permit Truck. Impact loads (dynamic load allowance) for Highway Bridges shall be as per the AASHTO LRFD Bridge Design Specifications.

15.2.2.2.2 Dead Loads

The Contractor shall design all Highway Bridges for an initial 3-inch asphalt overlay (36 psf) wearing surface and waterproofing membrane.

15.2.2.2.3 Uplift

The Contractor shall proportion Bridge spans to avoid uplift at supports due to non-seismic loads.

15.2.2.2.4 Thermal Forces

The Contractor shall use temperature ranges for moderate climates per the AASHTO LRFD Bridge Design Specifications.

15.2.2.2.5 Seismic

The Contractor shall design all Structures for seismic requirements in accordance with the AASHTO LRFD Bridge Design Specifications.

15.2.2.2.6 Load Rating

The Contractor shall load rate all new Highway Bridges, box culverts, and Bridge widenings in accordance with the AASHTO Manual for Bridge Evaluation, Second Edition with current interim revisions and the CDOT Bridge Rating Manual. Structures designed in accordance with the LRFD Design Specification shall be rated by the Load and Resistance Factor Rating (LRFR) method. Structures that are not designed in accordance with the AASHTO LRFD Bridge Design Specification shall also be rated using LRFR. However, should the LRFR rating be insufficient, the structure shall be rated by the Load Factor Rating (LFR) method. Both the LRFR rating and the LFR ratings shall be submitted to CDOT. Load ratings shall be provided electronically to CDOT prior to the commencement of any Bridge construction activities. Bridge widenings shall be rated as one system that includes both the portion of the remaining existing bridge and the new widening.

15.2.2.2.7 Wind Loads

The Contractor shall design all Highway Bridges for the wind loads specified in the AASHTO LRFD Bridge Design Specifications.

15.2.2.3 Geotechnical Data and Investigation

Geotechnical investigations conducted in the area of the Structures are included in "Preliminary Subsurface Investigation" in Book 3. The Contractor shall determine the additional geotechnical information required and conduct supplemental investigations as necessary to complete the final design. When planning and conducting additional investigations, the Contractor shall refer to the referenced Book 3 geotechnical documents completed for this Project. Additional boring logs and laboratory test results shall be presented in similar format as those Book 3 documents.

The referenced Book 3 soil and rock samples collected as part of this geotechnical engineering exploration are available at the geotechnical firm:

Yeh and Associates, Inc.
2000 Clay Street, Ste 200
Denver, CO 80211 Phone: 303-781-9590
Contact: www.yeh-eng.com

The Contractor shall have 90 Days from NTP 1 to take possession of these geotechnical samples. If the Contractor has not taken possession within this timeframe, the above geotechnical firm will dispose of these materials accordingly. If the Contractor does take possession of these samples, the Contractor shall assume full responsibility for both their storage and disposal.

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.

Geotechnical investigations shall comply with the requirements of the 2016 CDOT Field Materials Manual, AASHTO LRFD Bridge Design Specifications-Chapter 10 (Table 10.4.2-1-Minimum Number of Exploration Points and Depth of Exploration), and any other applicable standards necessary to perform the Work. All supplemental investigations made by the Contractor shall be documented in geotechnical investigation reports of similar format as those referenced geotechnical documents and submitted to CDOT for review and comment prior to Acceptance within 30 days following completion of the fieldwork. All supplemental investigations made by the Contractor for non-CDOT roadways shall be documented in separate Geotechnical Investigation Reports according to the maintaining entity and submitted to CDOT for Acceptance. No additional compensation will be provided for any additional costs for subsurface exploration work within areas of contaminated soil or groundwater.

15.2.2.4 Structure Foundation Analysis and Design Recommendations

The Contractor shall perform geotechnical analysis as required for the design of foundations for retaining walls, Bridges and other Structures. Design recommendations and substantiating analysis shall be documented in a draft form for the Preliminary Design Plans submittal and in final form for the Released for Construction (RFC) Review Documents submittal.

15.2.2.5 Structure Aesthetics

The Contractor shall adhere to the Project Aesthetic Plan in Book 3. Any further refinements shall be submitted to CDOT for Acceptance prior to any associated structural submittals, which includes the following:

Treatment concepts and details for all structures (Bridges, retaining walls, noise walls, etc.) shall meet the requirements of this Section 15, shall be consistent with and complement the existing corridor aesthetic treatments, and shall provide (as a minimum) the baseline aesthetic treatments, approach, and commitments included in the Project Aesthetic Plan in Book 3. Contractor shall coordinate with local agencies in order to obtain acceptance of formliner pattern used on retaining walls and noise walls for the Project. Formliner pattern selection shall be limited to the options shown in the Project Aesthetic Plan in Book 3.

As a minimum, the structure aesthetics shall include the following:

- 3:1 (Vertical to Horizontal) slope on bridge abutment front face.
- Widen existing bridge piers in-kind using wall piers. New piers at I-25 interchange shall complement the existing I-25/C-470 interchange ramp piers.
- Wingwalls (including extension of wingwalls as a retaining wall) shall be placed behind approach slab and bridge rail as a single face. Two tiered wingwalls are not required.
- Acceptable retaining wall facing: precast concrete panels and cast-in-place concrete. Modular block facing is not acceptable.
- Structural Concrete coating shall match the color of the existing bridges.
- Structural Concrete coating limits on slope paving shall include the existing and new slope paving. For locations where there is an adjacent bridge not included in this project with continuous slope paving, the coating limit on the slope paving shall extend to the closest edge of deck of the adjacent bridge.

15.2.3 Bridges

15.2.3.1 Geometry

All fill and cut slopes along the longitudinal axis of Bridges with spill-through abutments shall not be steeper than 2:1 (H:V) perpendicular to abutment. There shall be a 2-foot minimum width berm at the top of the slopes at the front face of abutments and a 2-foot minimum vertical dimension from the top of this berm to the bottom of girder. Minimum vertical clearance of 16 feet, 6 inches (from traveled way and outside edge of shoulder) shall be provided for all grade separations with one exception. The minimum vertical clearance under structures F-16-KL and F-16-KM (C470 over Erickson Blvd.) shall be 14 feet, 6 inches. The Contractor shall also maintain the existing minimum vertical clearance, or better, over the traveled way and outside edge of shoulders at existing and proposed Bridges during construction of the Project.

For bridge widenings, the concrete slope paving shall also be widened and should match the existing concrete slope paving layout.

15.2.3.2 Type

Bridge and retaining wall types will not be restricted to those historically used by CDOT. Other types will be allowed, but only if they have been accepted for general use by other state or federal transportation authorities. The Contractor must also demonstrate that the design of the Bridge and retaining wall types and components will meet the Project criteria and perform well

under the Project's environmental conditions, including frequent freeze-thaw cycles, anti-icing and de-icing. Experimental Bridge and retaining wall types, timber Bridges, masonry Bridges and structural-plate arches will not be allowed. Bridges shall incorporate as few joints and bearings as possible, be continuous over supports, not use intermediate hinges, and use integral or semi-integral abutments wherever possible. Bridge types selected shall allow for and facilitate future Bridge widening unless approved by CDOT. Avoid the use of fracture critical bridges. The Contractor shall submit, for Approval, all proposed Bridge and retaining wall types historically not used by CDOT in the Structural Concept Plans/Report.

15.2.3.3 Inspection Access

All Bridge superstructures, joints, and steel reinforced elastomeric bearing pads with sliding surfaces and high load multi-rotational (HLMR) bearings shall be made accessible for long-term inspections and maintenance and shall be designed and detailed for ease of replacement. Jack locations and required jack sizes shall be shown on the Released for Construction Documents. The Bridge shall be designed to withstand anticipated applied loads and forces with the superstructure jacked at the locations shown on the Released for Construction Documents.

Superstructures consisting of I-girders with exposed cross frames shall be made accessible for inspection either with walkways (see CDOT Bridge Design Manual) or by use of an A-40 inspection truck. All concrete or steel box girders with an inside depth of 5 feet or more shall be made accessible for interior inspection. All-pretensioned precast concrete box or tub girders with access shall be provided with low-point drainage through the bottom slab.

Access doors shall be placed at locations that do not impact traffic under the bridge, and shall be located to be readily accessible from bridge inspection trucks. All access holes shall be accessible with ladders from the ground and shall not require access by use of a CDOT A-40 inspection truck. Where access doors are provided above slope paving, cleats to support a ladder shall be provided in the slope paving and on steel girders. Location of access doors shall be submitted, no later than 30 Days prior to fabrication, for Approval by CDOT. CDOT Standard Structural Worksheet B-618-2 shows typical bottom-slab access-door details. The doors shall swing into the box girder. Box girders shall be protected from access by vermin. The minimum opening for access doors shall be 2 feet by 3 feet and door shall be secured by a single padlock. Access holes through diaphragms shall be 2 feet, 6 inches in diameter, minimum. Access doors shall include lock protectors.

15.2.3.4 Components

15.2.3.4.1 Bridge rails and pedestrian fencing

The Contractor shall design and construct bridge rails and pedestrian fencing (on bridges with sidewalks) that match the face, color and overall shape of barriers as defined in the Project Aesthetic Plan in Book 3 and according to this Section 15. The Contractor shall use bridge rails on approach slabs. The Contractor shall design and construct pedestrian fencing/railing in accordance with AASHTO LRFD Bridge Design Specifications. Bridge rails, decks, and approach slabs subject to vehicular impact shall be designed to meet TL-4 loading in accordance with AASHTO LRFD Bridge Design Specifications. Current CDOT Bridge rails that meet the above criteria, such as Type 7 and Type 10 Bridge rails, are acceptable and do not have to be designed and crash tested. Alternate railing proposed shall be required to meet these requirements and be crash tested. Only Type 7 Bridge Rails will be used on this project unless approved by CDOT. All bridge rail on existing bridges identified in Table 15.0.1 shall be

replaced with Type 7 Bridge Rail on both sides of each bridge deck and approach slabs (both directions) regardless whether or not the bridge is widened. Existing wingwalls and retaining walls shall be removed to a minimum of 12 inches below the bottom of the new approach slabs.

Place splash guard on all new bridge rail (except where median is closed) constructed over crossing streets, highways, ramps and trails. Use CDOT Bridge Structural Worksheet Fence Chain Link (Special) (36 Inch Splash Guard) Drawing B-607-3.

Pedestrian railing attached to Bridge rails shall be installed behind the bridge rail face, or back side of the bridge rail. All pedestrian fencing mounted on bridge structures shall meet fencing and screening requirements in the AASHTO LRFD Bridge Design Specifications. Cover plates shall be used over the face of joints on the interior and exterior concrete bridge rails, and on curbs and sidewalks to provide structural and safety shape continuity across the joint.

Place 1 extra 2 inch diameter conduit in bridge rails along outside shoulders. The extra conduit shall extend 2 feet beyond end of sleeper beam at both ends of bridge and terminate in a junction box. The Contractor shall coordinate final location of conduit with roadway typical section beyond the sleeper beam.

15.2.3.4.2 Approach Slabs

The Contractor shall provide an approach slab at each end of each Bridge. Provide an overlay on the approach slab as required in Section 15.2.3.4.5. All 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. For existing bridges that are widened, completely replace the existing approach slabs and expansion joints on the remaining portion of the existing bridge. For bridges that are less than 50 feet wide (i.e., edge of deck to edge of deck), the end of the approach slab (i.e., adjacent to pavement), including expansion joint, shall be placed normal to centerline of roadway. Approach slabs shall be separate from, and fit between, cantilevered wingwalls or retaining wall wingwalls so that the approach slab can freely rotate about the abutment. Bridge rails shall be connected to approach slabs. The Bridge rails shall be designed to function as a barrier to keep water out of the joint between wingwall/retaining wall and the edge of approach slab. The approach slab for Highway Bridges shall be at least the same width as the Bridge deck, and provide for expansion and contraction at the approach pavement interface where required. Approach slabs shall be anchored to the abutment. The Contractor shall design and construct an underdrain system beneath all approach slabs to remove water at Bridge abutments. Backfill behind the abutments shall be as shown in the CDOT Bridge Structural Worksheets Backfill Drawings B-206-F1 or B-206-M1. Bridge approach slab drains shall be located so as to minimize the amount of water flowing across all joints.

Differential settlement across approach slabs shall be designed such that they will not produce a grade break that is more than 1/2-inch within one (1) year of Final Acceptance. The Contractor shall implement ground improvement techniques to the approach embankment subgrade if necessary to meet this requirement.

15.2.3.4.3 Decks

The Contractor shall provide a minimum concrete deck thickness of 8 inches, except that decks and toppings for prefabricated pedestrian truss Bridges or adjacent precast prestressed box Bridges shall be 5 inches minimum. Open or filled grating decks and orthotropic decks will not

be permitted. Concrete decks designed to the simplified "Ontario", or any empirical methods, will not be permitted. Full depth precast deck slabs shall require cast-in-place 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. Stay-in-place metal deck forms are permitted. If stay-in-place metal forms are used, the superstructure, substructure, and foundation shall be designed for an extra 5 pounds per square foot (psf) minimum dead load applied to the superstructure. Parallel Bridges shall either have a minimum 2-inch (4-inch preferred) longitudinal gap between decks or parapets or shall be tied together to make one Bridge. Permanent deck forms will not be allowed for cast-in-place post-tensioned box girders, T-girder deck slabs, or cantilevered portions of decks. Cast-in-place concrete placed on top of a precast double tee or precast box girders shall be considered composite with the precast top flange if the minimum total laminated deck thickness is 8 inches, the minimum cast-in-place thickness is 5 inches and the top surface of the precast top flange is roughened. Precast double tees or precast box girders without a cast-in-place deck placed on top will not be allowed. If any part of a deck resists tension, the stress in the deck in this area shall not exceed 0.0948 times the square root of f'c, $(0.0948 \times (f'c)^{1/2})$ where f'c is in ksi. Minimum longitudinal steel in the top mat of cast-in-place decks shall be #4s at 6-inch spacing spliced to the negative-moment steel reinforcing over piers.

15.2.3.4.4 Deck Joints

The Contactor shall avoid or minimize joints wherever possible. Bridges in length up to 640 feet (steel) or 790 feet (precast or cast-in-place concrete) shall be jointless, wherever possible, according to guidelines given in CDOT Bridge Design Manual. A minimum 0 to 4-inch joint shall be placed at the end of approach slabs. Only strip seals for joints as reflected in CDOT Bridge Structural Worksheet - Bridge Expansion Device (0-4 inch) B-518-1, or CDOT Approved equal, with expected maximum 4-inch movement or modular joints for expected movements of 4-inches or greater shall be allowed. Design and location of joints shall provide for maintenance accessibility and future replacement. Aluminum joints will not be permitted. Modular joints shall be designed by LRFD and shall include LRFD fatigue requirements. Modular joints shall be tested for fatigue loading according to National Cooperative Highway Research Program (NCHRP) Report 402, Fatigue Design of Modular Bridge Expansion Joints (1997) Appendix A & Appendix B. All expansion devices shall be set to provide a smooth surface between the final grade into the device and the final grade out from the device. A smooth surface is defined as a maximum grade break, at or 30 feet either side of the device, of 0.3 percent. To facilitate the proper placement of expansion devices, the tabular Bridge geometry shall include a bent line for the expansion devices on a Bridge or approach slab. Asphaltic expansion devices and asphaltic plug joints shall not be used for any new construction.

End dam on approach slab shall be designed to accommodate a 3-inch wearing surface.

15.2.3.4.5 Overlays

The Contractor shall provide an initial overlay system for all Bridge decks. Bridge overlays shall be 3-inch minimum SMA over a waterproofing membrane, or a thin-bonded overlay (polyester concrete) on the bridge deck and approach slabs. The overlay shall be used on both the Bridge deck and associated approach slabs. Latex-modified overlays shall not be used. Pedestrian Bridges do not require an overlay.

On existing bridges to be widened, Contractor shall remove existing asphalt and waterproofing membrane on bridge decks and replace with a waterproofing membrane and a 3 inch SMA overlay or a thin-bonded overlay (polyester concrete). Use only one overlay type for all bridges on the Project.. Prior to placement of the new overlay, the bridge deck shall be rehabilitated as described in Section 15.2.3.6 Bridge Deck Rehabilitation and the Project Special Provisions at the end of this Section.

15.2.3.4.6 Superstructures

The Contractor shall ensure that all superstructure elements meet the requirements for redundancy, fatigue, crack control, and deflection in the AASHTO LRFD Bridge Design Specifications.

Utilities to be supported by Structures shall be submitted to CDOT for Approval no later than 30 Days prior to construction. Utility supports and other details shall be designed by a Professional Engineer licensed in the State of Colorado. Utilities shall be hidden from view in superstructure elevation. Bridge deck drainage or anti-icing pipes shall not be allowed inside of box girders or embedded within concrete structural members.

For structural steel superstructures, redundant-member structures are preferred. For cast-in-place concrete box girder superstructures, the Contractor shall consider the effects of a temperature gradient. The design of cast-in-place concrete box girders shall include the weight of the deck formwork left in place in the design of the superstructure, substructure, and foundation.

The maximum shear reinforcement spacing for cast-in-place mildly reinforced or post-tensioned concrete Bridges shall be 18 inches. The minimum amount of shear reinforcing per web for prestressed concrete girders shall be at least Av=135 x b'/fy, with b' the web width in inches, and fy the yield strength of the shear reinforcing in psi. Webs shall have at least double this minimum reinforcement for a distance d in front of anchorages. Minimum side-face steel shall be 1.5 times the minimum shear steel for areas more than the depth of girder from the supports and shall be spaced at 12 inches maximum. All reinforcing steel shall have a minimum 2 inch clearance between parallel bars including spirals.

Under full dead load, without live load and after all losses, no part of the top or bottom girder fiber which resists moments using prestressing shall be in tension. Under full loads, after losses, tension due to live load will not be permitted if well distributed fully bonded reinforcing is not provided in these areas. Negative camber is prohibited in precast concrete members.

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

When utilizing continuity for design of precast prestressed girders, the effects of differential shrinkage, differential temperature, and any redistribution of moments due to creep shall be investigated. The transverse steel area in precast box girder flanges shall, at a minimum, be equal to the minimum required shear reinforcing steel for one web.

Precast girders used in segmental construction shall be bonded with epoxy or concrete closure pours. The top surface of precast deck panels shall be roughened perpendicular to the longitudinal axis of the Bridge to ensure composite action between the precast and cast-in-place

slab. The minimum amount of non-prestressed longitudinal steel required in the cast-in-place portion of the slab shall be 0.2 square inch per foot width of slab.

All steel girders shall be designed to be fully composite with the deck along the entire length of the structure. All shear studs on steel girders shall be field welded. The minimum flange thickness (excluding the bottom flange of box girders) shall be 5/8-inch, and the minimum thickness of steel to which shear studs are to be connected shall be at least 0.33 times the stud diameter. The minimum flange width shall be 12 inches. The minimum thickness of the bottom flange of a box girder shall be 3/8- inch. The minimum thickness of any stiffener or web plate of a girder shall be 3/8-inch. The thickness of any web or flange plate shall not change by more than a factor or two at any splice (see CDOT Bridge Detail Manual, Chapter 13.2, for welded plate girder detail guidelines). Cover plates shall not be used. Longitudinal flange stiffeners shall not be used except for spans exceeding 165 feet between points of zero dead-load moment. Transverse stiffeners shall be normal to the top flange and placed on the non-visible side (inside) of exterior girders. Shop splices of stiffeners, if any, shall be made with full penetration groove welds. These welds shall be completed before the stiffeners are welded to the girder. Stiffeners with diaphragms connected to them shall be welded with fillet welds to the top and bottom flange. The skew angle between bearing stiffeners and web shall not be less than 60 degrees.

All splices shall be normal to the top flange and normal to the longitudinal axis of the girder. Field splices shall preferably be located at or near points of dead load contraflexure. The full penetration welds at girder shop splices shall be made without backing.

Field connections shall not be welded, but shall be made with high strength bolts. All full penetration welds shall be ground flush for testing. Slip critical connections shall be made with 3/4 inch, 7/8 inch, or 1 inch diameter ASTM A325 bolts.

Shear connectors shall penetrate at least three inches above the bottom of the slab. The minimum cover from top of deck to top of stud for bare decks shall be 3 inches and for decks with an overlay and membrane shall be 2 inches.

The use of pins and hangers will not be allowed. The Contractor shall avoid Category D or poorer weld details in tension zones subject to fatigue stress ranges. The design life of the structure for fatigue calculations shall be 75 years.
The location of all Fracture Critical Members (FCMs) shall be clearly delineated on the drawings. The Bridge design notes shall contain the supporting calculations and evaluations as to which members are designated FCMs and why they are so designated. CDOT shall be notified of any new Bridge containing FCMs. The Bridge designer shall provide the half-size copies of the Bridge drawings showing the FCMs and their details. These members and their details shall be highlighted. In addition, the fracture critical form that will be posted in the structure folder shall be obtained from CDOT and filled out with the correct information. This form and the highlighted drawings shall be submitted to CDOT with the rating package for the Bridge.

The Contractor shall follow the Shop Detail Drawing Review/Approval Guidelines developed by the AASHTO/NSBA Steel Bridge Collaboration G1.1-2000 for preparation of steel shop drawings.

Contractor shall comply with fabrication inspection requirements of bridge girders included in Book 3, Section 15.

15.2.3.4.7 Bearings

The Contractor shall design and locate bearings to allow maintenance accessibility and future replacement. Substructure drawings shall show locations for lifting when removing bearings. Elastomeric pads and steel reinforced elastomeric bearings, with or without sliding surfaces, are the preferred bearing types. Sliding surfaces shall be polytetrafloroethylene (PTFE) with a stainless steel mating surface. Bearings shall be either elastomeric pads (CDOT Type I), steel reinforced elastomeric bearings with or without PTFE and stainless steel sliding surfaces (CDOT Type I or Type II), or HLMR bearings (CDOT Type III). The thickness of Type II bearings shall be designed so that the acceptable shear deflection limits of the pad are not exceeded if slip does not occur. The design of elastomeric pads and steel reinforced elastomeric bearings shall be such that pad walk-out will not occur by including pad-walkout restraints. Sole plates shall have a 3/4 inch minimum thickness. At expansion bearings, the edge of the sole plate shall not slide past the edge of the elastomeric pad by the use of a positive stop. The Contactor shall provide at least 3 inches of cover between anchor bolt centerlines and the edge of the concrete pedestal. The Contactor shall provide reinforcement for pedestals greater than 3 inches high. Suppliers of bearings devices shall only be those on CDOT's pre-approved product list. Only one bearing type shall be used across the width of the Bridge at any given substructure location. Elastomeric pads and steel reinforced elastomeric bearing devices shall not be mixed with HLMR bearings at any one particular Bridge. The maximum bearing height for Type 1 bearings shall be 7 inches.

15.2.3.4.8 Piers and Pier Caps

The Contractor shall design a type of pier and pier cap that will be consistent with the Project Aesthetic Plan in Book 3 and according to this Section 15. Drop caps or integral caps are acceptable. Integral caps are preferred with cast-in-place concrete box superstructures. The Contractor shall minimize the use of integral steel pier caps. Inspection access for integral steel pier caps shall be provided. Aesthetic treatments on piers shall extend below existing grade and be considered for ultimate template as necessary to accommodate future construction. Concrete guardrails shall not be cast monolithically with integral pier caps.

15.2.3.4.9 Abutments

The Contractor shall provide integral, or semi-integral, end diaphragm-type abutments for Bridges whenever possible. See CDOT Bridge Design Manual, Section 7.2-Mechanically Stabilized Earth (MSE) walls, which may serve as abutment support for Bridge superstructure loads and as meeting the requirements of the “Retaining Walls” subsection in this Section 15. Retaining wall wingwalls may be used in lieu of cantilevered wingwalls at abutments for all categories of Bridges and according to the Project Aesthetic Plan in Book 3 related to Aesthetics and this Section 15. Cantilevered wingwalls and/or retaining walls shall extend 4 feet beyond the point of intersection of the embankment slope with the roadway finished grade. Bridge monuments shall be supported on separate foundations.

15.2.3.4.10 Slope Protection

The Contractor shall provide concrete slope protection for all slopes under Bridges, and on slopes between tiered walls. Concrete slope and ditch paving shall be required on slopes from shoulder to top of retaining walls when the slope is steeper than 4:1 or when the clear distance

between edge of roadway shoulder or back of guardrail to the face of retaining wall is less than 24 feet. Slope
protection shall conform to details contained in CDOT Standard Structural Worksheets Slope Paving Details, Drawings No. B-507-1 and B-507-2, unless noted otherwise herein. Slope protection on slopes between tiered walls and any slopes from shoulder to the top of retaining wall shall use similar detail. Contractor may substitute an approved riprap for concrete slope protection at the South Platte River.

15.2.3.4.11 Foundations

The Contractor shall ensure that differential settlement shall not exceed 1/2 inch within a bent or abutment. Differential settlements between adjacent bents or abutments shall not exceed span length (in feet)/400. The Contractor shall design for down-drag where required. Spread footings are acceptable if the bottom of the footing is located below frost heave, scour elevation, and are an Accepted foundation type in the Foundation Design Report to be prepared by the Contractor. Foundations of integral abutments with skews between the axis of the abutment and the direction of allowed movement shall be designed to resist the unbalanced earth pressures behind the abutments.

The Contractor's Quality Management Plan (QMP) shall include inspection and testing of all drilled caisson operations. Non-destructive testing for non-redundant (single shaft) drilled caissons is required. Cross Sonic Log (CSL) or impact echo are acceptable methods of non-destructive testing for drilled caissons. Additional methods for non-destructive testing, that are in accordance with the AASHTO/ASTM/FHWA guidelines, may be considered for use on this Project subject review and/or acceptance of CDOT and incorporation into the Approved QMP.

Dynamic monitoring of driven-pile foundations using the Pile Driving Analyzer (PDA) tests shall be performed at a minimum of two piles per Structure, each at a separate foundation element (abutment or pier foundation), and at a minimum of 2 percent of driven piles for the Project to verify pile capacity with appropriate resistance factor meets or exceeds the design factored load per pile. The PDA tests shall cover pile size, hammer type, and geology condition changes for Structures. The PDA tests shall include the measurements for initial driving and restrike. The Contractor may replace or supplement PDA tests with static load tests for piles. Static load tests shall be in accordance with ASTM D-1143 or ASTM D-3996. The exact number, type, layout and location of static and PDA tests will be per the Contractor's QMP, subject to incorporation into the Approved QMP. Static axial load tests or PDA on driven piles shall be performed in locations where driven piles will be used and the vertical loads will control the depth of the driven piles. Driven piles are allowed on this Project if noise constraints of the local entity are met.

15.2.3.4.12 Drainage and Scour

Bridge deck drainage and approach slab drainage systems shall be designed in accordance with the CDOT Bridge Design Manual. Stormwater flowing toward the Bridges shall be intercepted prior to flowing onto the approach slab. Stormwater which falls on bridges shall be intercepted before it reaches expansion joints. All stormwater shall be directed to an outfall conforming to the Contract requirements. Permanent erosion protection shall be designed and installed at all outfall locations to prevent the occurrence of erosion. Outfalls shall have a well-defined and protected channel or pipe flow path. Sheet flow will not be allowed. Energy dissipation in the channel shall be required.

All Bridge deck drain inlets shall be grated. The Bridge deck drainage system shall be compatible with the structural reinforcement, components, and aesthetics of the Bridge. Outfalls shall be positioned to avoid corrosion of structural members, and drainage or splash on vehicular traffic and pedestrian of bike areas below the Bridge. Downspouts for Bridge drains shall be minimum 10-inch diameter galvanized steel pipe, and shall meet the requirements of ASTM A53, Grade B, and standard weight schedule 40. Downspout pipe shall be hot dipped galvanized after fabrication. Galvanizing shall meet the requirements of AASHTO M111. Metal used in the manufacture of castings shall meet the requirements of ASTM A48, Class 35B. Cleanouts shall be provided for downspout systems.

Bridge deck drains shall be located so that downspouts can be taken immediately down pier columns. Bridge drain systems with "horizontal" runs shall not be used. The Bridge deck system shall also comply with requirements listed in Book 2, Section 12.

The Bridge deck drain system shall be designed and constructed to be easily modified to accommodate future changes to the width on the Bridge.

Scour analyses shall be based on the procedures in the FHWA HEC-18, Scour at Bridges, and HEC-20, Stream Stability at Highways. Scour countermeasures shall be designed in accordance with the FHWA HEC-23, Design of Countermeasures.

15.2.3.4.13 Utilities

The Contractor shall identify, maintain, and coordinate all Utility locations on Structures. Hanging of electrical conduits, telephone conduits, or other Utilities shall not be permitted under deck overhangs or on Bridge rail. Protection of conduits from the settlement of the abutment backfill shall be provided. Utility placement on Structures shall be by the Approval of CDOT according to requirements of this Section 15. Utilities shall be hidden from view in superstructure elevation.

15.2.3.4.14 Median

Concrete median barrier supported on the Bridge deck and approach slabs shall be constructed to allow for removal and modification in the future without causing damage to the Bridge deck or approach slab concrete or reinforcement.

15.2.3.5 Maintenance Plan

The Contractor shall submit to CDOT, for Acceptance with the final plans and specifications submittal, a maintenance plan for each new and existing Bridge describing routine maintenance and items specific to each component of the Bridge. It shall also include a detailed list of all maintenance and rehabilitation work and the number of times each procedure is anticipated to be performed over the 75-year Bridge life itemized by the year performed. This list shall be the same as that used for life cycle cost analysis provided in accordance with the Contract.

15.2.3.6 Bridge Deck Rehabilitation

The existing bridge decks that remain as part of a bridge widening shall be rehabilitated. The Contractor shall remove and dispose of existing deteriorated bridge deck concrete in accordance with Project Special Provisions at the end of this Section.

All bridge decks and approach slabs shall be protected with an overlay as described in Section 15.2.3.4.5 Overlays. Prior to removal of concrete and placement of the new overlay, the bridge deck shall be sounded by the Contractor in the presence of the Contractors ICQC Team, Contractors Engineer, and CDOT for delaminations according to ASTM D-4580. All unsound concrete shall be marked, measured, and removed at locations mutually agreed on between the Contractors Engineer and CDOT. Class 1 removals are permitted only when the thin-bonded overlay (polyester concrete) is used. All damaged or corroded reinforcing shall be replaced with reinforcing steel (epoxy coated). Removal areas shall be repaired with Concrete Class D, polymer polyester concrete, or approved equal as defined in the Project Specifications. When using polymer polyester concrete for overlay, use Deck Repair worksheet in Reference Drawings. Quantities for the bridge deck rehabilitation have been determined by CDOT and are shown in Table 15.2.3.6. All bridge deck rehabilitation quantities are to be included in the work and are to be approved by the Engineer as described in the Project Specifications. However, should the actual quantities for bridge deck rehabilitation vary by more than 5% of the quantities shown in Table 15.2.3.6, CDOT will consider a price adjustment using the change order process. No change order will be allowed for any overlay quantities, regardless of type.

Table15.2.3.6
Bridge Deck Rehabiliitation Estimated Quantities

Item No.	Description	Unit	Quantity when using SMA and waterproofing membrane as overlay	Quantity when using Polymer Polyester Concrete as overlay
202-00450	Removal of Portions of Present Structure (Class 1)	Square Yard	Not allowed	400
202-00453	Removal of Portions of Present Structure (Class 2)	Square Yard	500	100
202-00460	Removal of Portions of Present Structure (Class 3)	Square Yard	40	40
601-03040	Concrete Class D (Bridge)	Cubic Yard	60	20
602-00020	Reinforcing Steel (Epoxy Coated)	Pounds	3000	900

15.2.3.7 Removal of Bridges or Structures

A removal report/plan for each Bridge or Structure to be removed, or partially removed, shall be submitted to CDOT for review, a minimum of fourteen (14) Days before removal operations begin. The report/plan shall describe methods of removal, equipment to be used, and sequence of removal. The report/plan shall document any structural analysis that was done for different stages of removal and explain whether or not any portion of the Bridge or Structure will remain over traffic during the different stages of removal. The report/plan shall describe any areas of concern for worker safety. The report/plan shall also describe the length of time for the removal, anticipated roadway closures and proposed detours, the estimated total number of worker shifts,

effects of removal on pedestrians, bicycle, and traffic, locations where removed Bridge material will be temporarily stockpiled, and requirements for disposing of removed material including any material painted with lead-based paint.

The Contractor shall be responsible for verifying existing structure surveys and as-built plans prior to design of removals, rehabilitations or widenings. The Contractor shall be responsible for adjusting its designs to accommodate any variances identified in the field relative to the survey and as-built information provided.

A removal report/plan shall also be submitted to CDOT for review, a minimum of fourteen (14) Days before removal operations begin for removal, of retaining walls supporting or adjacent to traffic or pedestrian activities, sound walls, overhead sign structures and traffic signals on the Project.

Bridge removal shall consist of the complete removal (or partial removal as shown on plans) of all existing superstructures and substructures prior to construction of new Bridges as further described in the Standard Specifications and this Section 15.

Removal of the substructure shall be taken down to at least 1 foot below the future ground surface at the lowest point of interface, including consideration of any current or future improvements identified by the Urban Drainage and Flood Control District as well as other current or future recreational uses in all other areas of the Project. Holes resulting from substructure removal shall be backfilled with Structure Backfill (Class 2) to the adjacent existing grades. The Contractor shall schedule a pre-removal meeting at least ten (10) Days prior to removal operations. The meeting shall be coordinated with the Project Director and include CDOT representatives from Traffic, Safety, Public Involvement, and Staff Bridge.

15.2.4 Box Culverts

15.2.4.1 Existing Box Culverts

Existing box culverts and drainage facilities within the Project design shall be extended as needed to satisfy new project geometrics. Anticipated box culverts requiring extension as well as new box culverts are listed in Section 15.0.

15.2.4.2 Design

New or extended box culverts, replacements, extensions, strengthening of existing box culverts, headwalls, and wingwalls shall meet all requirements of the Project. CDOT's M-Standards shall be used. Box culverts not covered in the CDOT M-Standards shall be designed in accordance with AASHTO LRFD Bridge Design Specifications, CDOT's Bridge Design Manual, and CDOT's Drainage Design Manual. All box culverts, new and reuse of existing, shall be load rated, documented and submitted to CDOT.

15.2.4.3 Maintenance Plan

The Contractor shall provide to CDOT, for review with the final plans and specifications submittal, a maintenance plan for each box culvert structure type used. This plan shall describe routine maintenance and items specific to each component of the specific structure type. It shall also include a detailed list of all maintenance and rehabilitation work and the number of times each procedure is anticipated to be performed over the 75-year structure life, itemized by the year performed.

15.2.5 Retaining Walls

15.2.5.1 Retaining Wall locations

Preliminary permanent retaining wall locations have been identified on the Roadway plan reference drawings. Final retaining wall types and sizes will be determined by the Contractor and shall be designed and constructed with the requirements in Section 15.0 Structures.

The following criteria shall apply to permanent wall Structures. Walls that support traffic for interim phases of traffic which are left in place and become part of the final Structure shall be considered permanent walls and 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.

15.2.5.1 Geometry

The retaining wall layout shall address slope maintenance above and below the wall and provide returns into the retained fill or cut at retaining wall ends. Final tolerances shall be 1 to 200 for level and plumb. Any residual wall batter shall be into the fill. Where 12 feet (minimum) of generally level terrain is not available between the wall and the ROW line for maintenance access, the wall shall be located a minimum of 10 feet inside the ROW line.

Design and construction shall consider surface and subsurface drainage. Walls which support soil and loads from outside ROW, and are built with MSE soil reinforcements, shall require an appropriate setback from ROW line for the construction of the wall or a temporary construction easement shall be required in accordance with requirements in Section 8, Right-of-Way. A system shall be provided to intercept or prevent surface water from entering behind walls. Lengths of wall without relief joints shall be limited to lengths which control the differential settlement. A safety railing shall be provided at the top of all walls adjacent to bicycle or pedestrian facilities as required by Chapter 14 of the CDOT Roadway Design Guide. A 3-strand cable fence shall be provided at the top of all other retaining walls and culvert ends greater than 4-feet of exposed height. The 3-strand cable fence shall be designed and constructed in accordance with the Project Special Provision – Revision of 607 Fence (Special) at the end of this section.

15.2.5.2 Type

Metal walls, including bin and sheet pile walls, recycled material walls, Mechanically Stabilized Earth (MSE) (Block) walls, and timber walls shall not be permitted for permanent retaining walls. Wall types, selected by the Contractor, shall have been used successfully in similar geotechnical locations and environmental conditions.

15.2.5.3 Design Requirements

All 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. Fencing on walls shall satisfy OSHA, and/or CDOT maintenance requirements. Outlets for backfill drainage for any retaining wall type shall be shown on the plans.

Mechanically Stabilized Earth (MSE) walls shall be designed in accordance with the requirements of AASHTO LRFD Bridge Design Specifications. Global stability, overturning,

sliding, and settlement calculations shall be performed on all retaining wall systems. MSE wall designs integrated with the abutments shall also address thermal movement of the bridge and approach settlement. All retaining wall installations shall provide for a positive drainage system of the backfill. The design of 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 that the foundation of the wall is located below the scour level. In addition the wall 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.

All walls near irrigation lines for landscaping shall account for any additional hydrostatic load due to a waterline break. The Contractor may consider the use of free draining backfill material and/or leak detection devices to reduce hydrostatic loads on retaining walls. Retaining walls shall be designed according to the seismic criteria from AASHTO LRFD Bridge Design Specifications.

Temporary retaining walls (constructed of materials not allowed for permanent walls) may be abandoned and left in place. Temporary retaining walls left in place must be completely covered by soil or construction material 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 of the structural support elements and materials of the permanent retaining walls meet the requirements of this Section 15.

15.2.5.4 Characteristics

15.2.5.4.1 Mechanically Stabilized Earth (MSE) (Panel) Walls

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 exposed to splash from traffic shall use epoxy coated reinforcing steel. Panel joints shall accommodate differential settlement per AASHTO LRFD Bridge Design Specifications.

A technical representative shall be at the job site, as required by the Project Specifications in Book 2 Section 20, to assist the Contractor with the Approved Quality Management Plan. The Contractor shall use the latest FHWA geotechnical references and guidelines in conformance with the Contract, as provided at the following website: http://www.fhwa.dot.gov/engineering/geotech/index.cfm, including the FHWA Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes - Volumes I and II.

A barrier shall be provided to prevent fine washout between horizontal and vertical facing panel joints, panel wall construction joints, or relief joints.

15.2.5.4.2 Mechanically Stabilized Earth (MSE) (Block) Walls

MSE Block type walls shall not be allowed for use on this Project.

15.2.5.4.3 Cast-in-Place Walls

Cast-in-place walls shall be designed and constructed in accordance with AASHTO LRFD

Bridge Design Specifications. Construction joint spacing shall accommodate or limit differential settlement. Foundations shall be designed per the geotechnical design requirements and recommendations.

15.2.5.4.4 Anchored Walls

Design and construction shall use FHWA DP-90-068, FHWA RD-82-046, FHWA RD-82-047, "Design Manual for Permanent Ground Anchor Walls" FHWA RD-97-130, "Geotechnical Engineering Circular No. 4 - Ground Anchors and Anchored Systems" FHWA IF-99-015 as guidelines. Anchors shall be encapsulated with plastic sheathing. Proof load tests for anchors shall be provided in accordance with the above FHWA guidelines.

15.2.5.4.5 Soil Nail Walls

Soil nail walls may only be used when top-down construction is warranted. Soil nail walls shall not be used if ground water seepage will occur. Design and construction shall use FHWA-RD-89-93, "Soil Nailing Field Inspectors Manual" FHWA SA-93-068, "Manual for the Design & Construction Monitoring of Soil Nail Walls" FHWA SA-96-069R, and "Geotechnical Engineering Circular No. 7 - Soil Nail Walls" FHWA IF-03-017. Load testing for nails shall be provided in accordance with the above FHWA guidelines. The exposed surface of pneumatically placed concrete shall meet the aesthetic requirements of the Project Aesthetic Plan in Book 3 and this Section 15.

15.2.5.4.6 Structural Diaphragm Walls

Structural diaphragm walls may be used when top-down construction is warranted.

15.2.5.4.7 Soil Reinforcement

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

15.2.5.5 Retaining Wall Aesthetics

All retaining walls throughout this Project shall comply with the Project Aesthetic Plan in Book 3 and requirements in this Section 15. All wall facing shall be of a consistent type (i.e. cast-in-place, precast facing, etc.) within any section of road, interchange and single viewshed. This includes surface treatment, pattern, texture, color, and jointing layout. An overall negative batter (wall face leaning outward away from fill) between the bottom and the top of the wall is not allowed. Wall facing shall be installed vertically (plus or minus 1/2 inch in 10 feet or as defined in the CDOT Bridge Structure Worksheets for MSE walls) and shall be capped with a cast-in-place or precast concrete cap. Wall facing and cap shall be colored with pigmented sealer.

The Contractor shall produce and submit to CDOT a visual graphic of each retaining wall to demonstrate aesthetic conformance to the Project Aesthetic Plan in Book 3 and requirements in this Section 15. This graphic shall be submitted in both hard and electronic format. In all cases, proposed retaining wall aesthetics graphics shall include all visible surfaces and slope protection and submitted to CDOT for Approval with the Contractor's proposed general layouts

of each Structure. This submittal shall include drawings illustrating form, texture, and color. As part of the submittal, the Contractor shall provide full-size mockups (10 ft. x 10 ft. minimum) for all surface treatments for texture, color, and quality for Approval by CDOT. For Project consistency, retaining walls within a common viewshed shall incorporate similar visual aesthetics. Retaining walls for parallel Bridges shall have similar Structure types and aesthetic treatments.

All Structures with visible concrete surfaces, including those accessible by graffiti vandals, shall have a surface treatment of structural concrete coating. This includes all retaining walls, noise walls, bridge abutments and piers, bridge barriers, and slope protection.

15.2.6 Noise Walls

Noise walls, if required, shall be designed and constructed in accordance with the AASHTO LRFD Bridge Design Specifications. Noise walls shall be designed for an 80-mph wind with specified gust factor (30 percent). Final tolerances shall be 1/8 inch in 1 foot for level and plumb. The design of noise walls shall provide for adequate surface drainage. Noise walls within 10 feet of traffic shall be designed for a minimum wind load of 27 psf. When the installation of a noise wall interferes with the access to existing, or proposed fire hydrants, the noise wall installation shall include fire hose access openings and associated identification signs. Location and demand for these openings shall be established in cooperation with the local fire department.

15.2.6.1 Geometry

When placed behind guardrail, noise walls shall be offset according to applicable standards for that particular guardrail. The Contractor shall place noise walls on top of concrete guardrail when offset space is limited to 10 ft. or less.

15.2.6.2 Components

15.2.6.2.1 Panels

Panels shall be constructed of cast-in-place or precast concrete. Panels on Bridges shall be cast-in-place concrete and jointed from longitudinal structural elements of the Bridge. Panel design and construction shall consider ease of replacement and/or repair, and shall limit the risk from falling debris resulting from traffic impacting with the noise wall.

15.2.6.2.2 Posts

Posts shall be reinforced concrete or prestressed concrete or painted structural steel.

15.2.6.2.3 Foundations

Foundations shall be posts set in concrete, flowfill, caissons, cast-in-place, or precast reinforced concrete footings. The bottom of all spread footing foundations shall be placed a minimum of 3 feet below finished grade. Reinforcing steel projecting into the above ground portion of walls, subject to splash from the Roadway (areas within 10 feet horizontally of the edge of travel lane), shall be epoxy-coated.

15.2.6.3 Noise Wall Aesthetics

All noise walls throughout this Project shall comply with the Project Aesthetic Plan in Book 3 and requirements in this Section 15.

15.2.7 Sign Structures

Major sign Structures and supports for Intelligent Transportation System (ITS) equipment shall be designed and constructed in accordance with AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 6th Edition with current Interim Revisions. The Contractor shall provide minimum vertical clearances in accordance with the above specified AASHTO requirements and loadings shall consider natural period of vibration from vortex shedding and upward wind pressures from passing trucks. Sign Structures shall be galvanized structural steel (single) tubing, painted in accordance with the Project Aesthetic Plan requirements in Book 4. Draft structural worksheets for single-tube sign supports are available from CDOT Staff Bridge Branch. The Contractor shall not mount major sign supports (cantilevered signs, sign bridges, etc.) on MSE retaining walls. However, if unavoidable, the Contractor shall coordinate sign support design with the MSE wall manufacturer to ensure wall design and details will support sign loads.

Variable Message Signs (VMSs) shall be mounted on a sign structure. The Contractor shall prepare a structural design for each VMS structure in accordance with the submittals for Major Structures as defined in the current CDOT Bridge Design manual and Section 15.

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

15.2.7.1 Components

15.2.7.1.1 Foundations

Drilled caissons shall be used to support overhead and cantilever sign Structures as well as ground mounted VMS Structures. The Contractor shall prepare one general project foundation report for all sign Structures and shall have one foundation boring within 10 ft. of each single caisson supporting large sign supports.

15.2.7.1.2 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.

15.2.7.1.3 Bridge Mounted Signs

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

15.2.8 Pedestrian Bridges

15.2.8.1 Design Criteria

In addition to the criteria outlined here, new or modified pedestrian Bridge truss structures shall follow the CDOT Specification Section 628 – Bridge Girder and Deck Unit. Pedestrian Bridge truss structures shall be designed and constructed in accordance with the CDOT Bridge Design Manual, AASHTO LRFD Guide Specifications for Design of Pedestrian Bridges 2nd edition with

current interims, and the AASHTO LRFD Bridge Design Specifications. The Contractor shall provide a 17'-6" minimum vertical clearances in accordance with CDOT and AASHTO requirements. Unless determined otherwise by the Contractor, the pedestrian Bridge does not need to be designed for the CDOT Type 3 Legal Load Vehicle as required in CDOT's Bridge Design Manual – Subsection 2.2. Pedestrian railing shall be in conformance with the Project Aesthetic Plan in Book 3 and extended to the ends of approach slabs as a minimum. Curbs shall be provided on each side of the pedestrian walkway to prevent water from flowing onto the area below and to allow mounting of any required fence posts if needed.

15.2.9 Tunnels

No Tunnels are anticipated for this Project.

15.2.10 Submittals and Reviews

15.2.10.1 Preliminary Design Plans (30%)

The Contractor shall submit Preliminary Design Plans (30%) for all Major Structures as defined in the current CDOT Bridge Design Manual, all proposed sound walls, and box culverts which deviate from the CDOT M&S Standards for Review prior to proceeding to final design and preparation of the Final RFC Documents. The Preliminary Design Plans will include Structural Concept Plans, Structural Concept Reports, Life Cycle Cost Analysis, and Preliminary Foundation Investigation Reports.

15.2.10.1.1 Structural Concept Plans

Structural Concept Plans shall consist of General Layouts of all proposed Major Structures, sound walls and box culverts which deviate from the CDOT M&S Standards. Bridge plans shall be consistent with the detail requirements for General Layouts as defined by the current CDOT Bridge Detail Manual. For all retaining walls, sound walls, and box culverts the General Layouts shall provide plan, elevation, and typical section details similar to those provided for bridges.

15.2.10.1.2 Structure Concept Reports

Structure Concept Reports shall consist of a three-page description of the structure type, materials, foundation types, methods of accommodating differential settlement, design strategy for lateral loads, and design-life considerations for each proposed Structure. The reports shall include a description of creative or innovative ways the design, construction, and/or choice of structural types will benefit and/or enhance schedule, quality, and cost aspects of the Project and minimize traffic impacts. Provide a list of transportation authorities, actual projects and references for all Bridges, foundation types and retaining wall type not historically used by CDOT. Additional information provided for non-historic structures will not count toward the page limit. All non-historic structures will require CDOT Approval prior to proceeding with final design and preparation of the Final RFC Documents. This requirement supersedes the Review designations for other Preliminary Design Plans elements.

15.2.10.1.3 Life Cycle Cost Analysis

The Contractor shall submit a 75-year life cycle cost analysis for each proposed bridge type. The analysis shall clearly state and justify (using historical data) the assumptions used in determining life cycle costs.
Include construction cost and costs for scheduled maintenance and repair. The Contractor shall not include routine maintenance (sweeping, cleaning, graffiti, removal, etc.) or demolition and salvage at the end of the 75 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, decks, railings, overlays, joints, bearings and drainage systems. The Contractor shall use a 5 percent discount rate and user cost of $10.00 per vehicle-hour of delay at year one. The Contractor shall use the present worth method to develop a present total Bridge cost. Life cycle cost analysis shall be based on methods and procedures developed by the National Institute of Standards and Technology (NIST) Bridge LLC or the National Cooperative Highway Research Project (NCHRP) 12-43 Life-Cycle Cost Analysis for Bridges.

15.2.10.1.4 Preliminary Foundation Investigation Report

The Contractor shall submit a Preliminary Foundation Report for each major structure and minor structures as required for the design of foundations for Bridges, retaining walls, sound walls, and other Structures. The report will 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.

15.2.10.2 Pre-Released for Construction (RFC) Review Documents

The Contractor shall submit Released for Construction (RFC) Review Documents for all Structures for Review prior to the submittal of the Final RFC Documents. Documents which are required for this submittal include plans and specifications for all Structures, maintenance plans for bridges and box culverts, Bridge and box culvert load ratings, and foundation investigation reports. Project aesthetic details shall have been incorporated into the plans. The foundation investigation reports shall be revised from the preliminary foundation investigation reports and be the basis for the load analysis from seismic and earth loads and the basis for the design of foundation elements. Additional soil borings required for the Structural design shall have been completed.

15.2.10.3 Final RFC Documents

Upon completion of the comment resolution process identified by the Contractor's Approved QMP resulting from the Pre-Released for Construction (RFC) Review Documents submittal, the Contractor shall submit Final RFC Documents for Acceptance. The Final RFC Documents shall include resubmittal of all elements provided in the Pre-Released for Construction (RFC) Review Documents submittal with all comments addressed as outlined in the QMP. The Final RFC Documents shall include final plans and specifications for all Structures, design calculations and independent design calculations for all major structures as defined by the current CDOT Bridge Design Manual, independent detail checks of the plans and specifications for Major Structures as defined by the current CDOT Bridge Design Manual, maintenance plans for bridges and box culverts, Bridge and box culvert load ratings, foundation investigation reports, and final submittal letter.

15.2.10.3.1 Final Plans and Specifications for Structures

The final plans and specifications for each Structure shall be signed and sealed by the Contractor's designer in accordance with 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 computer disk (CD or DVD) or other approved format.

15.2.10.3.2 Design and Independent Design Calculations

The design calculations and independent design check calculations shall be signed and sealed by the Contractor's designer in accordance with laws for registration of Professional Engineers in the State of Colorado. Copies in PDF and MicroStation electronic format shall be made of all design and design-check calculations for the Project and submitted to CDOT on computer disk

(CD or DVD) or other approved format. All calculations shall 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.

15.2.10.3.3 Bridge and Box Culvert Maintenance Plans

The Contractor shall submit for Approval maintenance plans for all Bridge and box culvert Structures as described in Section 15. This requirement supersedes the Acceptance designations for other Final RFC Documents elements.

15.2.10.3.4 Bridge and Box Culvert Ratings

A Rating Package as defined by the current CDOT Bridge Rating Manual shall be completed and submitted for each Bridge and box culvert as described in Section 15.

15.2.10.3.5 Foundation Investigation Reports

The foundation investigation reports shall be signed and sealed by the Contractor's designer in accordance with laws for registration of Professional Engineers in the State of Colorado.

15.2.10.3.6 Final Submittal Letter

The Contractor's designer shall submit a letter to CDOT certifying that all Structural plans and specifications have been prepared in accordance with the current design standards of CDOT.

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

Falsework and shoring plans shall be signed and sealed by a Professional Engineer licensed in the State of Colorado. Shop Drawings and working Drawings shall be reviewed and approved by the Contractor's structural design engineer. 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 CDOT 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 computer disk (CD or DVD) format.

The Contractor shall follow the Shop Detail Drawing Review/Approval Guidelines developed by the AASHTO/NSBA Steel Bridge Collaboration G1.1-1999 for preparation of steel shop drawings.

Shop Drawings shall be submitted to CDOT for information only. The Contractor is solely responsible for Shop Drawing accuracy.

15.2.10.5 Construction Requirements

The CDOT Permit Office shall be notified 2 Working Days in advance of reductions in vertical clearances or when lane closures, lane reductions, or lane width restrictions are put into effect.

Bridge deck and approach slab surface smoothness shall not deviate more than 3/8 inch in 25 feet as described in the Standard Specifications.

A technical representative shall be at the job site, as required by the Project Specifications in Book 2 Section 20, to assist the Contractor with the Approved Quality Management Plan. The representative shall maintain a construction diary and sign-off on all hold points as defined in the Contractor's Approved Quality Management Plan. The diary shall be submitted with the final Design Documents

15.3 Deliverables

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

Deliverable	Review, Acceptance, or Approval	Schedule
Alternative Bridge Rating Software	Approval	Prior to the preparation of Bridge or Box Culvert Ratings
Supplemental Geotechnical Investigation Reports	Acceptance	30 days following completion of field work
Structure Concept Reports for Non-historically used structures	Approval	As part of the Preliminary Design Plans (30%) Package Submittal
Bridge widening girders which are shallower than existing girders	Approval	Prior to initiation of design
Refinements to the Project Aesthetic Plan	Acceptance	Prior to associated structure submittals
Visual Graphic of each retaining wall	Approval	Prior to the Preliminary Design Plans (30%) Submittal
Structural Concept Report	Acceptance	As part of the Preliminary Design Plans (30%) Package Submittal
Preliminary Foundation Investigation Report	Acceptance	With the Preliminary Design Plans (30%) Package for each Structure or noise wall for the Project
Pre-Released For Construction Review Documents	Review	Prior to submittal of Final RFC Documents
Final Plans and Specifications Package	Acceptance	As part of Final RFC Documents submittal
Design and independent design calculations	Acceptance	As part of Final RFC Documents submittal
Bridge and box culvert Maintenance plan	Approval	As part of Final RFC Documents submittal
Bridge and box culvert load rating (including BrR import files)	Acceptance	As part of Final RFC Documents submittal
Foundation Investigation Reports	Acceptance	As part of Final RFC Documents submittal
Final Submittal Letter	Acceptance	As part of Final RFC Documents submittal
Location of access holes/doors	Approval	30 Days prior to fabrication
Concrete mix design and procedures	Acceptance	At least 3 weeks prior to the anticipated concrete placement date
Utilities supported by Structures	Approval	30 Days prior to construction

Deliverable	Review, Acceptance, or Approval	Schedule
Falsework or Shoring plans carrying live traffic	Acceptance	10 days prior to construction.
Bridge/other structure removal report/plan	Review	14 Days prior to removal operations begin
Additional non-destructive methods for testing drilled caissons	Acceptance	As required, for construction of drilled caissons
As-built drawings with shop drawings and working drawings	Acceptance	Prior to final inspection of the work

All deliverables shall also conform to the requirements of Section 3, Quality Management.

Project Special Provisions

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REVISION OF SECTION 202
REMOVAL OF PORTIONS OF PRESENT STRUCTURE

Section 202 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of the removal and disposal of existing deteriorated bridge deck concrete. Removal operations shall be conducted so that there will be the least interference with public traffic using the structure.

The applicable classes of removal will be as shown on the plans or as determined by the Engineer.

CONSTRUCTION REQUIREMENTS

a) General:

At least 10 days before start of work, the Contractor shall submit to the Engineer details of the removal operations showing the methods and sequence of removal and equipment to be used. The Contractor's submittal shall also include proposed methods used to determine the locations of deteriorating concrete.

All methods and equipment used to accomplish this item shall be approved by the Engineer.

Prior to removal of concrete, the bridge deck shall be sounded by the Contractor in the presence of the Contractors ICQC Team, Contractors Engineer, and CDOT for delaminations in accordance with ASTM D4580. All unsound concrete shall be marked, measured, and removed at locations mutually agreed on between the Contractors Engineer and CDOT. The Contractor will not be compensated for removal areas or patching areas not mutually agreed on between the Contractors Engineer and CDOT.

The Contractor shall remove and repair only the amount of work that can be completed and opened to traffic within the designated lane closure times as specified in the Traffic Control Plan.

The Contractor shall take all steps necessary to prevent cutting or otherwise damaging reinforcing steel, including any vertical stirrups, and/or structural steel including welded shear connectors projecting into the bridge deck. All bars or shear connectors damaged by the Contractor's operations shall be repaired or replaced at the Contractor's expense.

Following sandblasting, the condition of all exposed reinforcing bars shall be inspected by the Engineer. If, in the opinion of the Engineer, the bars are deteriorated to less than 75 percent of their original cross section, the Contractor shall add additional bars as approved by the Engineer. New added bars shall be lap spliced as shown in the plans. Payment for

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REVISION OF SECTION 202
REMOVAL OF PORTIONS OF PRESENT STRUCTURE

the new reinforcement steel shall be made in accordance with Section 602. If the required lap splice length cannot be utilized, a mechanical splice shall be used. The mechanical splice shall develop at least 125 percent of the specified yield strength of the bar. The Mechanical splice shall be per CDOT list of approved products. All minimum clearances shall be maintained. Payment for the Mechanical splice will be as the weight of reinforcing steel for the designated lap splice for that bar size. As an alternative, the Contractor may remove additional sound concrete to achieve the required lap length. Payment for

additional removals and repairs will be based on the unit price for the appropriate class of removal and repair method. Removal and repairs beyond the minimim required lap length will not be paid for.

All reinforcing steel shall be secured to adjacent bars or to the bridge deck as provided in subsection 602.

All areas of the prepared surface contaminated by oil or other materials detrimental to good bond shall be thoroughly cleaned by a method approved by the Engineer. Such cleaning work will not be paid for separately, but shall be included in the work.

b) Class 1:

Class 1 removals shall be used only on bridge decks receiving a thin bonded polyester concrete overlay and shall consist of removing spalling concrete areas to a depth not less than ¾" and not deeper than the center of the top mat of reinforcing steel. Class 1 removal shall consist of removing the surface of the existing bridge deck concrete within the limits shown on the plans, or as designated by the Engineer.

Removal may be performed by chipping, hand tools or shot blasting (sand blasting) in accordance with these specifications or as otherwise approved by the Engineer.

If loose or deteriorated concrete exists below Class 1 limits, Class 2 removal may be required.

Class 1 removals are not allowed if thin-bonded overlay (polymer concrete) is not used.

c) Class 2:

Removal of Portions of Present Structure (Class 2) shall consist of removing existing bridge deck concrete within the limits shown on the plans, or as designated by the Engineer. Class 2 removal shall begin at the surface of the existing concrete bridge deck and extend to sound concrete, but not less than 1 inch below the top transverse and longitudinal reinforcing steel and shall extend at a maximum to the top of the bottom mat of reinforcing or half bridge deck thickness, whichever is less.

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REVISION OF SECTION 202
REMOVAL OF PORTIONS OF PRESENT STRUCTURE

Wherever solid bond between existing concrete and reinforcing steel is lacking, or where more than half of the diameter of the reinforcing bars is exposed by removal of concrete, the concrete adjacent to the bar shall be removed a minimum of one inch below and around the bar to permit new construction to bond to the entire periphery of the bar. Pneumatic hammers heavier than nominal 15 lb. class shall not be used in removing concrete from below and around reinforcing steel**.** Care shall be taken so as not to fracture sound concrete in the bottom half of the bridge deck.

Removal may be performed by power chipping or hand tools in accordance with these specifications or as otherwise approved by the Engineer.

If loose or deteriorated concrete exists below Class 2 limits, Class 3 removal may be required.

d) Class 3:

Removal of Portions of Present Structure (Class 3) shall consist of removing existing bridge deck concrete within the limits shown on the plans, or as designated by the Engineer, following the Class 2 removal work. The concrete within the designated limits shall be removed full depth from the top of bridge deck to bottom of bridge deck.

The Contractor shall take all precautions necessary to prevent damage to diaphragms and girders below the removal limits and to minimize spalling on the bottom of the bridge deck slab adjacent to the removal boundaries.

e) Surface Preparation Equipment

Sandblasting equipment shall be capable of removing rust scale from reinforcing bars and removing small chips of concrete partially loosened or fractured by the scarifying or chipping operations.

Pneumatic hammers heavier than nominal 15 pound class will not be permitted. Pneumatic hammers and chipping tools shall not be operated at an angle exceeding 60° relative to the surface of the slab. Such tools may be started in the vertical position but must be immediately tilted to 60° operating angle.

Hand tools such as hammers and chisels shall be provided for removal of final particles of loose, unbonded concrete. Only short, one-handed hammers with a maximum head weight of 5 pounds will be allowed unless Class 3 removal is designated.

METHOD OF MEASUREMENT

Removal of Portions of Present Structure will be measured by the actual area of square yards, completed to the required depth for each class, and accepted. A given bridge deck

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REVISION OF SECTION 202
REMOVAL OF PORTIONS OF PRESENT STRUCTURE

surface area of removal will be measured as only Class 1, 2 or Class 3; measurement of removal areas will not overlap.

BASIS OF PAYMENT

Payment will be made under:

Pay Item	**Pay Unit**
Removal of Portions of Present Structure (Class 1**)	Square Yard
Removal of Portions of Present Structure (Class 2)	Square Yard
Removal of Portions of Present Structure (Class 3)	Square Yard

** Note: Class 1 removals are not allowed if thin-bonded overlay (polymer concrete) is not used.

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REVISION OF SECTION 202
REMOVAL OF ASPHALT MAT (PLANING) (SPECIAL)

Section 202 of the Standard Specifications is hereby revised for this project as follows:

Subsection 202.02 shall include the following:

All asphalt material and waterproofing membrane shall be removed from the surface of the concrete.

For bridges which are to receive a new waterproofing membrane and new asphalt, the surface of the deck shall be relatively smooth upon completion of removal operations. Jagged or broken edges, that could damage the subsequent waterproofing membrane, shall be removed or ground smooth.

The Contractor is responsible for the condition of the deck prior to and during placement of the new surface treatment.

Subsection 202.09 shall be replaced with the following:

Prior to beginning removal operations, the Contractor shall submit a removal plan for approval. This plan shall include as a minimum:

(1) Methods of removal including confined areas that are unreachable with large equipment.
(2) The type and number of all equipment to be used. If cold milling is to be performed for removal of the final ½ inch of asphalt, appropriate information must be provided to demonstrate the equipment meets the requirements of this specification.

The width, location and phasing of removal passes along with the proposed schedule for these passes.

The Contractor shall remove the existing asphalt by cold milling to within ½ inch of the concrete deck. Removal of the remaining ½ inch of asphalt and any existing membrane shall be performed by any one or combinations of the following three methods:

1) Scraping with a loader equipped with a smooth edged bucket (no teeth).
2) Diamond grinding.
3) Cold milling with equipment that has the capabilities and features as described below.

Cold milling equipment must be able to:

1) Remove concrete to a depth of ¼ inch.
2) Provide a surface relief of at most ¼ inch.
3) Provide a 5/32 inch grade tolerance.

Cold milling equipment must have the following features:

1) 3 or 4 riding tracks.
2) An automatic grade control system with electronic averaging having 3 sensors on each side of the equipment.

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REVISION OF SECTION 202
REMOVAL OF ASPHALT MAT (PLANING) (SPECIAL)

3) A conveyor system that leaves no debris on the bridge.
4) A drum that operates in an up-milling direction.
5) Bullet tooth tools with tungsten carbide steel cutting tips.
6) A maximum tool spacing of ¼ inch.
7) A maximum operating weight of 66,000 pounds.
8) A maximum track unit weight of 6,000 pounds per foot.
9) New tooth tools at the start of the job.

For all cold milling operations, the Contractor shall:

1. Provide personnel on each side of the milling drum to monitor milling activities. Maintain constant radio communication with the operator during milling activities.
2. Verify the depth of the asphalt surfacing every 50 feet at one location on each shoulder and in the traveled way.
3. Saw cut the outline of the asphalt surfacing to be removed.

A small width rotomill (maximum 2-foot head) and low impact hand tools may be used in confined areas where the primary removal equipment will have difficulty accessing.

In the transverse direction, removal shall extend to the face of the barriers. The removal depth near the face of the barriers shall be consistent with the remainder of the bridge deck.

Hydrodemolition and pressure jetting will not be permitted for removal operations.

After cold milling is complete, the Contractor shall ensure that the coarse aggregate remaining above the removal depth is firmly embedded and remove it if it is not.

The Contractor shall prepare the bridge deck surface for placement of the new surface treatment.

If cold milling is to be performed for removal of the final ½ inch of asphalt, the Contractor shall furnish a documented history of successfully performing cold milling on bridge decks with equipment similar to that described herein. The documentation shall include three projects within the past five years and shall include equipment type used as well specifics regarding the bridges.

The Contractor shall take all precautions to minimize damage to the expansion devices, barriers and drains. All damage to the bridge expansion devices, barriers and drains resulting from removal operations shall be repaired at the Contractor's expense without time extension.

The Contractor shall take all precautions to minimize damage to the bridge deck that would not ordinarily occur with the removal methods described herein. This includes damage to deck reinforcing and post-tensioning. Such damage resulting from removal operations shall be repaired at the Contractor's expense without time extension.

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REVISION OF SECTION 202
REMOVAL OF ASPHALT MAT (PLANING)(SPECIAL)

The Contractor shall provide protection to live traffic and waterways below from any falling debris in work areas where heavy equipment is in use.

Asphalt planing edges shall be tapered if the planing is not completed within the allowable lane closure time and is more than ¾ inch higher in elevation than the adjacent pavement.

Tapered edges transverse to the direction of traffic shall be at a 20:1 (horizontal:vertical) slope. Tapered edges longitudinal to the direction of traffic shall be at a 4:1 (horizontal:vertical) slope.
All removal operations shall be completed parallel to the travel lanes unless otherwise directed by the Engineer.

Subsection 202.11 shall be replaced with the following:

The contract price paid per square yard for Removal of Asphalt Mat (Planing)(Special) includes full compensation for furnishing all labor, materials, tools, equipment and incidentals and for doing all the work involved in removing the asphalt and any waterproofing membrane as shown on the plans, as specified in the these special provisions, and as directed by the Engineer. The cost for placing a wedge of material along vertical drop-offs greater than 3 inches shall be included in the work.

Subsection 202.12 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Removal of Asphalt Mat (Planing)(Special)	Square Yard

The work associated with preparation of the bridge deck surface shall be included as part of the surface treatment item.

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REVISION OF SECTION 518
BRIDGE EXPANSION DEVICE

Section 518 of the Standard Specifications is hereby revised for this project as follows:

In subsection 518.04, delete the second paragraph and replace with the following:

The device shall consist of a continuous premolded elastomeric expansion joint seal (also called neoprene gland) and steel extrusions as shown on the plans, required by the manufacturer, or specified herein for attaching the elastomeric expansion joint to the steel anchors. The expansion device shall have a rated range of movement of 4 inches including rotations.

In subsection 518.04, delete the fourth paragraph and replace with the following:

Steel extrusions and cover plates shall conform to the specifications of ASTM A588, whereas other structural steel shall conform to the specifications of ASTM A709 Grade 36 or ASTM A588. Fabrication and welding of structural steel shall conform to the requirements of Section 509. The material designations for all steel components shall be shown in the Contractor's shop drawings.

In subsection 518.04, delete the fifth paragraph and replace with the following:

All structural steel elements of the bridge expansion device, including cover plates, shall be galvanized after fabrication in accordance with Section 509, whether or not they are in contact with the elastomeric joint seals. Installation hardware does not require galvanizing.

Subsection 518.04 shall include the following:

Where only a portion of an expansion device is to be replaced, the Contractor shall field verify existing steel extrusion/anchor dimensions that need to be replaced. The Contractor shall provide verification to Engineer for approval.

In subsection 518.09, delete the first and second paragraph and replace with the following:

The Contractor shall furnish shop drawings in conformity with subsection 105.02 for all elastomeric expansion devices bid under this section. Shop drawings shall specifically identify each piece, location of welding, bends in the extrusions, galvanizing, and installation hardware. The manufacturer's instructions for proper installation of the expansion joint device shall be included in the shop drawings. Shop drawings which lack manufacturer's installation instructions shall be returned for resubmittal.

Where applicable according to plans, details of the expansion device through the curb, and details of the curb cover plates and connections, shall be shown on the shop drawings.

In subsection 518.09, delete the fourth paragraph and replace with the following:

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REVISION OF SECTION 518
BRIDGE EXPANSION DEVICE

A qualified technical representative of the manufacturer shall be on site to provide guidance during installation of the expansion device and installation of the elastomeric expansion joint seal.

Subsection 518.13 shall include the following:

The cost for the qualified technical representative of the manufacturer shall be included in the work.

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

Section 519 is hereby added to the Standard Specifications as follows:

DESCRIPTION

519.01 This work consists of furnishing and placing a Polyester Polymer Concrete (PPC) overlay system with a High Molecular Weight Methacrylate (HMWM) resin primer on concrete surfaces. The surface of the concrete shall be prepared and the PPC overlay system shall be applied in accordance with these specifications in conformity with the lines, grades, thickness, and typical cross-sections shown on the plans or as approved by the Engineer.

This work includes patching of Class 1 and Class 2 deck removal areas using polyester concrete material. Polyester patching of Class 2 removal areas shall be limited to 10 square feet per patch and no more than 10 percent of the deck area per span. Additional patching of Class 2 and all Class 3 removals shall require Concrete as designated in the plans.

QUALIFICATIONS AND SUBMITTALS

519.02 The Contractor shall submit the Overlay System, System Provider Qualifications, Contractor Qualifications, System Provider Technical Representative Qualifications, Overlay Placement Plan, Certificates of Compliance with laboratory testing for each property, and any other relevant documents for the overlay system at least 15 days prior to the Polyester Overlay Pre-paving Conference and delivery of any of the overlay materials. These submittals are for approval and shall be directed to the Engineer.

(a) ***Overlay System:*** The Contractor shall submit two copies of the System Provider's material information, written installation instructions, material safety data sheets, and independent test results for approval.

(b) ***System Provider Qualifications:*** The Contractor shall install an overlay system with all components provided through a single System Provider, with documented experience successfully supplying 5 projects of similar size and scope within the past 5 years. The Contractor shall submit documentation of the System Providers project experience including the following:

(1) Project construction date
(2) Overlay quantities
(3) Reference name and contact information for owner representative

(c) ***Contractor Qualifications:*** The Contractor shall submit documentation of successful projects placing structural concrete (bridge decks or concrete pavement) and PPC overlay systems to established grade lines using similar equipment as specified herein within the past 5 years. The documentation of Contractors qualifications shall include the following:

(1) Project construction date
(2) Overlay quantities
(3) Reference name and contact information for owner representative

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

If the Contractor does not have 5 years of experience placing structural concrete and PPC overlay systems with at least 10 documented successful projects, the Contractor shall arrange for a qualified System Provider Technical Representative with 5 years of documented experience with PPC to be on site throughout the duration of the project to ensure proper construction of the polyester concrete.

If the Contractor has 5 years of experience placing structural concrete and PPC overlay systems with at least 10 documented successful projects, the qualified System Provider Technical Representative with 5 years of documented experience with PPC shall, at a minimum, be on site throughout the placement of the first two bridge overlay placements and shall be available for the remainder of the project as requested by the Engineer.

(d) ***System Provider Technical Representative Qualifications:*** The System Provider Technical Representative shall have a minimum of 5 years of experience with PPC and be completely competent in all aspects of the work, including all materials to install the overlay system. The Technical Representative shall have experience on a minimum of 5 successful projects of similar size and scope within the past 5 years. The Contractor shall submit documentation of the System Providers Technical Representative's experience including the following:

(1) Years of Experience with polyester concrete
(2) Project construction date
(3) Overlay quantities
(4) Reference name and contact information for owner representative

The Technical Representative shall be available on site to facilitate the installation of polyester concrete. This includes, but not limited to, surface preparation, polyester concrete application, and polyester concrete cure.

(e) ***Overlay Placement Plan:*** The Contractor shall submit an Overlay Placement Plan that includes the following:

(1) Schedule of overlay work and testing for each bridge
(2) Staging plan describing overlay placement sequence including:
  (i) Contractor shall pave from high side of the bridge to the low side; no gaps between passes will be allowed.
  (ii) Cold joints between passes shall be within 1 foot of the stripe lines or centered within a lane.
  (iii) Staging Plan Sheets shall describe overlay placement sequence including:
    -Paving widths
    -Anticipated paving lengths
    -Paving directions
    -Joint locations
    -Location of proposed trial overlay(s)
(3) Description of equipment used for:
  (i) Surface preparation including grinding and shot blasting
  (ii) Applying HMWM resin

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

(iii) Measuring, mixing, placing, and finishing the polyester concrete overlay
(iv) Applying sand
(v) Method of protecting and finishing inlets and bridge drains

(4) Method for preventing leakage of primer onto areas of deck that have not received surface preparation.
(5) Method for isolating expansion joints including pourable joints at the abutment and over the piers
(6) Method for measuring and maintaining overlay thickness and profile.
(7) Tining plan showing tining locations and describing methods that will be used for hand tining.
(8) Mainline tining shall be automated with the finisher.
(9) Cure time for polyester concrete
(10) Storage and handling of HMWM resin and polyester concrete components
(11) Procedure for disposal of excess HMWM resin, polyester concrete, and containers
(12) Procedure for cleanup of mixing and placement equipment

(f) *Equipment:* The Contractor shall submit documentation of current certification that equipment has been calibrated by a Caltrans California test CT 109.

The Contractor shall submit a documented history of the use of the paving machine to successfully place Polyester Polymer Concrete overlays on major bridge projects for review and approval by the Engineer.

MATERIALS

519.03 The Contractor shall submit a Certified Test Report for all of the materials associated with the polyester concrete overlay in accordance with subsection 106.13 and accompanied by certified test reports from independent accredited laboratories.

The polyester concrete shall consist of polyester resin binder and aggregate as specified below. It shall also include a compatible primer which when mixed with other specified ingredients and applied as specified herein, is capable of producing a polyester concrete meeting the requirements of this specification.

519.04 Polyester Resin Binder.
Polyester resin binder shall have the following properties:

(1) Be an unsaturated isophthalic polyester-styrene co-polymer. The resin content shall be 12% +/-1% of the weight of the dry aggregate.
(2) Contain at least 1 percent by weight gamma-methacryloxypropyltrimethoxysilane, an organosilane ester silane coupler.
(3) Be used with a promoter that is compatible with suitable methyl ethyl ketone peroxide and cumene hydroperoxide initiators.
(4) Have the values for the material properties shown in Table 519-1:

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

Accelerators or inhibitor may be required to achieve proper setting time of polyester concrete. They shall be used as recommended by the overlay System Provider.

Table 519-1
POLYESTER RESIN BINDER PROPERTIES (Tested each lot sent to the job)

Property	Test Method	Requirement
Viscosity*	ASTM D 2196	$0.1x10^{-5}$ to $2.9x10^{-5}$ psi (0.075 to 0.20 Pa) RVT No.1 Spindle, 20 RPM at 77 °F
Specific Gravity*	ASTM D 1475	1.05 to 1.10 at 77 °F
Elongation	ASTM D 638	35 percent, minimum Type I specimen, thickness 0.25 ± 0.03" at Rate = 0.45 inch/minute.
	ASTM D 618	Sample Conditioning: 18/25/50+5/70
Tensile Strength	ASTM D 638	2,500 psi, minimum Type I specimen, thickness 0.25 ± 0.03" at Rate = 0.45 inch/minute.
	ASTM D 618	Sample Conditioning: 18/25/50+5/70
* Test shall be performed before initiator is added		

519.05 High Molecular Weight Methacrylate (HMWM) Primer. Primer for the concrete surface shall be a wax-free low odor, high-molecular-weight methacrylate primer, and consist of a resin, initiator, and promoter. The primer shall conform to Table 519-2 and the promoter shall be as recommended by the System Provider.

Initiator for the methacrylate resin shall consist of a metal drier and peroxide. If supplied separately from the resin, the metal drier shall not be mixed with the peroxide directly. The containers shall not be stored in a manner that allows leakage or spilling to contact the containers or materials of the other.

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

Table 519-2
HIGH MOLECULAR WEIGHT METHACRYLATE RESIN PROPERTIES (Tested yearly)

Property	Test Method	Requirement
Viscosity*	ASTM D 2196	4.0×10^{-5} psi (0.025 Pa) maximum (Brookfield RVT with UL adapter, 50 RPM at 77 °F)
Volatile Content*	ASTM D 2369	30 percent, maximum
Specific Gravity*	ASTM D 1475	0.90 minimum at 77 °F
Flash Point	ASTM D 3278	180 °F minimum
Vapor Pressure*	ASTM D 323	0.04 inch Hg, maximum at 77 °F
PCC Saturated Surface-Dry Bond Strength (Adhesive)	California Test 551, part 5	700 psi, minimum at 24 hours and 70 ± 1°F (with polyester concrete at 12% resin content by weight of the dry aggregate)
*Test shall be performed before initiator is added		

519.06 Aggregates. Polyester concrete aggregate shall have the following properties:

(1) Have not more than 45 percent crushed particles retained on the No. 8 sieve when tested in accordance with AASHTO Test Method T335.
(2) Provide fine aggregate consisting of natural sand.
(3) Have a weighted-average aggregate absorption of no more than 1.0 percent when tested under AASHTO Test Methods T84 and T85.
(4) At the time of mixing with resin, have moisture content of not more than one half of the weighted-average aggregate absorption when tested under AASHTO Test Method T255.
(5) Comply with the requirements for the aggregate gradation shown in Table 519-3:

Table 519-3
AGGREGATE GRADATION (Tested yearly)

Sieve Size	Percent Passing
3/8”	100
No. 4	62-85
No. 8	45-67
No. 16	29-50
No. 30	16-36
No. 50	5-20
No. 100	0-7
No. 200	0-3

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Sand for abrasive sand finish shall have the following properties:

(1) Be commercial-quality blast sand.
(2) Have not less than 95 percent pass the No. 8 sieve and not less than 95 percent retained on the No. 20 sieve when tested under AASHTO Test Method T27.
(3) Have an average absorption of not more than 1 percent when tested under AASHTO Test Method T85.

519.07 Composite system.

Table 519-4
COMPOSITE PROPERTIES (Tested every 2 years)

Property	Test Method	Requirement
PPC Saturated Surface Dry Bond Strength	CT 551	500 psi minimum at 24 hrs. and 70F (without primer, at 12% resin content by weight of the dry aggregate, on Saturated Surface Dry Specimen)
Abrasion Resistance	CT 550	<2g weight loss (at 12% resin content by weight of the dry aggregate)
Modulus of Elasticity	ASTM C 469	1,000,000 psi to 1,500,000psi (at 12% resin content by weight of the dry aggregate)

CONSTRUCTION REQUIREMENTS

519.08 Polyester Overlay Pre-paving Conference. A Pre-paving Conference shall be held before any overlay paving operations begin. Attendees shall include all parties involved in the work.

519.09 Trial Application. Prior to constructing the overlay, one or more trial applications shall be placed on a previously constructed concrete base to determine the initial set time and to demonstrate the effectiveness of the mixing, placing, and finishing equipment proposed. The set time can be determined when the in-place PPC cannot be deformed by pressing with a finger, indicating the resin binder is no longer in a liquid state. Each trial application shall be the planned paving width, at least 6 feet long, and the same thickness as the specified overlay. The trial applications shall be tined as per the tining requirements in this specification for the final application. The trial application(s) shall replicate field conditions and be constructed using the same equipment as the production work. The location of the trial application(s) shall be approved by the Engineer. Trial applications shall be properly disposed of off-site by the Contractor.

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

The number of trial applications required shall be as many as necessary for the Contractor to demonstrate the ability to construct an acceptable trial overlay section and competency in ability to perform the work.

Overlay pull bond testing shall be performed in accordance with the acceptance testing herein. Acceptable test results shall be achieved on a trail application before the installation may proceed.

519.10 Equipment. All equipment for cleaning the existing concrete surface and mixing and applying the overlay system shall be in accordance with the System Provider's recommendations as approved by the Engineer prior to commencement of any work.

(a) ***Mixing Equipment:*** A continuous mixer shall be used for all polyester concrete overlay applications.

The continuous mixer shall:

(1) Employ an auger screw/chute device.
(2) Be equipped with an automatic metering device that measures and records aggregate and resin volumes. Record volumes at least every five minutes, including time and date. Submit recorded volumes at the end of the work shift.
(3) Have a visible readout gage that displays volumes of aggregate and resin being recorded.
(4) Produce a satisfactory mix consistently during the entire placement.

A portable mechanical mixer of appropriate size for proposed batches, as recommended by the System Provider and approved by the Engineer, may be used for all PPC patching applications and for smaller area applications of less than 2000 cubic feet per contract.

(b) ***Finishing Equipment*****:** A self-propelled slip-form paving machine, which is modified or specifically built to effectively place the PPC overlay in a manner that meets the objectives and requirements of the project, shall be used for all polyester concrete overlay applications. The paving machine shall:

(1) Employ a vibrating pan to consolidate and finish the PPC.
(2) Be fitted with hydraulically controlled grade automation to establish the finished profile. The automation shall be fitted with substrate grade averaging devices on both sides of the new placement; the device shall average 15 feet in front and behind the automation sensors. The sensor shall be constructed to work with string-line control. It is acceptable to match grade when placing lanes adjacent to previously placed PPC.
(3) Be equipped with controls capable of maintaining the screed at the specified transverse slope within plus or minus 0.1 percent.
(4) Have sufficient engine power and weight to provide adequate vibration of the finishing pan while maintaining consistent forward placement speed.

Finishing of patches of Class 1and Class 2 deck removal areas shall be completed using hand finishing tools to make it flush with the top of the existing deck surface.

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

519.11 Surface Preparation.

Existing bridge decks shall be repaired prior to the application of the polyester concrete overlay as shown in the plans and as determined in the field. Spalled and delaminated areas of the deck shall be removed down to sound concrete in accordance with Special Provision 202 – Removal of Portions of Present Structure. All removal areas shall be patched to provide a uniform overlay thickness.

Patching mortars with magnesium phosphate will not be allowed on decks receiving a polyester concrete overlay. Existing mortars that are over 28 days old may remain in place.

All cement-based deck patching material, including mortar and concrete, shall attain a minimum compressive strength of 3000 psi, cure a minimum 5 days, and pass the moisture transmission test prior to placing the polyester concrete overlay.

For newly constructed bridge decks and approach slabs, the deck shall cure a minimum of 28 days and attain the required Field Compressive Strength per Standard Specification 601 prior to overlay placement.

The surface of concrete substrate shall be prepared for application of the overlay by *shotblasting* in order to remove all existing grease, slurry, oils, paint, dirt, striping, cure compound, membrane, or any other contaminants that could interfere with the proper adhesion of the overlay system.

The final prepared surface shall adhere to the following requirements:

(1) The areas to be overlaid shall be cleaned by shotblasting or abrasive sandblasted in the event that the shotblaster cannot access areas to be prepared. Cleaning shall not commence until all work involving the repair of the concrete deck surface has been completed and the deck is dry. All contaminants shall be picked up and stored in the vacuum unit and no dust shall be created during the blasting operation that will obstruct the view of motorists in adjacent roadways. The travel speed and/or number of passes of the shotblasting unit shall be adjusted so as to result in all weak or loose surface mortar being removed and the aggregates of the concrete being exposed, as well as a visible change in the concrete color. Cleaned surfaces shall not be exposed to vehicular traffic unless approved by the Engineer. If the deck becomes contaminated before placing the overlay, the Contractor shall shotblast or abrasive sandblast the contaminated areas to the satisfaction of the Engineer at no additional cost.

(2) Any loose particles shall be removed prior to the overlay placement by magnets and compressed air and vacuuming such that no trapped particles remain. Power washing will not be allowed.

(3) The areas to be overlaid shall be blown off with compressed air just prior to placement of the primer and shall be completely dry.

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

(4) Surface Preparation Pull Bond Testing shall be performed by the Contractor and submitted to the Engineer for acceptance.

519.12 Application of Overlay. Methods shown in this specification are typical of general installations and may be modified per the System Provider's recommendations as approved by the Engineer. The application of the overlay shall not begin until the concrete deck is completely surface dry in accordance with ASTM D4263. The concrete surface temperature shall be between 40 and 100 °F. Night work may be required when temperatures cannot be met during the day. Stockpiled materials shall not be stored on the bridge deck.

(a) ***HMWM Primer Application:*** Immediately before placing primer, all exposed surfaces shall be completely dry and blown clean with oil-free compressed air. Exposed surfaces shall be protected from precipitation and heavy dew during and after the application of the primer.

After the exposed surfaces have been prepared and allowed to dry, primer shall be applied in accordance with the System Provider's recommendations. Primer shall be placed within 5 minutes of mixing at approximately 90sf/gal or the rate recommended by the System Provider.

Primer shall be uniformly spread to completely cover surfaces to be overlaid. Care shall be taken to avoid excess application that results in puddling. Excess material shall be removed or distributed to meet the required application rate. Primer shall be reapplied to any areas that appear dry after 15 minutes of absorbing the material.

Primer shall not be allowed to leak onto areas that have not received surface preparation.

(b) ***Polyester Concrete Application:*** The polyester concrete shall be applied after 15 minutes and within 2 hours after the primer has been applied. The polyester concrete shall be placed prior to gelling or 15 minutes following addition of initiator, whichever occurs first, or within a more restrictive range if recommended by the System Provider.

The polyester resin binder shall be initiated and blended completely. Aggregate shall be added and mixed for at least two minutes when a portable mechanical mixer is used.

Polyester concrete shall have an initial set time of at least 30 minutes and at most 120 minutes when tested using an initial-setting time Gillmore needle under ASTM C 266. The set time can be determined in the field when the in-place PPC cannot be deformed by pressing with a finger, indicating that the resin binder is no longer in a liquid state. If the initial set is not within 30-120 minutes, the material shall be removed and replaced.

The overlay shall be consolidated and finished to the required grade and cross-section using a PPC paver as defined herein.

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

Placement of the overlay to the profile and cross-section shall be controlled by taut reference line string-lines on both sides of the paver. Placement and finishing equipment shall use the string-lines as a reference for automatic hydraulic control of finished grade. The reference elevation and string-line shall be established by the Contractor and is subject to the approval of the Engineer.

Although the paver should yield a finished surface, additional finishing may be necessary. PPC shall be finished as necessary through traditional concrete finishing methods, producing a slight resin bleed indicating complete consolidation of aggregates.

A surface friction sand finish of at least 2.2 lbs. per square yard shall be broadcast onto the glossy surface immediately after finishing and before resin gelling occurs. To ensure adequate pavement friction, the completed PPC overlay surface shall be free of any smooth or "glassy" areas such as those resulting from insufficient quantities of surface aggregate. Any such surface defects shall be
repaired by the Contractor in the manner recommended by the System Provider and approved by the Engineer at no additional cost.

The coefficient of friction of the treated surface must be at least 0.35 when tested in accordance with California Test 342.

The overlay shall be longitudinally tined. Tining shall produce grooves of 1/8 inch by 1/8 inch spaced at ¾ - 1" inch apart. Tining grooves shall be neat in appearance and uniform in depth. Tining devices shall be maintained clean and free from encrusted mortar, polyester resin, sand and polyester concrete to ensure uniform groove thickness.

Unless indicated on the plans, tining shall run parallel with the direction of traffic and shall extend across the entire applied deck surface except for 1' next to the curb. The tining shall not be performed too early whereby the grooves may close up, or too late whereby the grooves are of inadequate depth.

All working deck joints shall be extended through the overlay and be sealed according to the details in the plans.

Polyester concrete overlay edges shall be tapered if the overlay is not completed within the allowable lane closure time and is more than ¾ inch higher in elevation than the adjacent pavement.

Tapered edges transverse to the direction of traffic shall be at a 20:1 (horizontal:vertical) slope. Tapered edges longitudinal to the direction of traffic shall be at a 4:1 (horizontal:vertical) slope. Tapers may remain and be overlaid with polyester concrete overlay.

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

(c) ***Curing*****:** The Contractor shall protect the overlay from moisture for a minimum of 4 hours. The Contractor shall allow the overlay to cure sufficiently before subjecting it to loads or traffic of any nature that may damage the overlay. Cure time depends upon the ambient and deck temperatures.
The overlay shall be considered cured to a firm, hard state when 4 hours have passed or a minimum reading of 25 on a properly calibrated Schmidt hammer.

519.13 Acceptance Testing. Acceptance of the deck patch, surface preparation, and thin bonded overlay will be determined by the Engineer based on moisture transmission tests, vertical axis pull bond tests, and smoothness quality testing performed by the Contractor.

(a) ***Deck Patch Moisture Transmission Testing:*** Moisture transmission tests shall be performed by the Contractor using the Plastic Sheet Method in accordance with ASTM-D4263. This test consists of an eighteen inch by eighteen inch square of clear plastic sheeting that is sealed to the concrete surface with tape on all four sides. After sixteen hours, if any condensation is found on the underside of the plastic or if the concrete surface is darkened, the test will be considered failing.

(b) ***Surface Preparation Pull Bond Testing:*** Vertical axis pull bond tests shall be performed by the Contractor in accordance to ACI 503R-30. This test consists of bonding a 2 inch diameter sandblasted steel disk to the prepared substrate by using a fast setting epoxy, and pulling it from the substrate by applying a vertical force.

A minimum of 2 pull-out tests shall be performed on each bridge. For bridges with deck areas greater than 25,000 square feet, additional tests shall be performed at a frequency of one test per 25,000 square feet of additional deck area, rounded up. Additional testing may be required as directed by the Engineer.

Substrate preparation will not be approved unless at least 90% of the bonded steel disk surface has retained substrate concrete exceeding 1/4 inches in depth.

(c) ***Overlay Pull Bond Testing:*** Vertical axis pull bond tests shall be performed after 24 hours by the Contractor in accordance to ACI 503R-30. At a minimum, 2 pull bond tests shall be performed on each bridge. For bridges with deck areas greater than 25,000 square feet, additional tests shall be performed at a frequency of one test per 25,000 square feet of additional deck area, rounded up. Additional testing may be required as directed by the Engineer.

The test result shall be the average of the number of tests for each structure, drilled a minimum of 0.25" but no greater than 0.50" below the bond line.

The bond strength of the PPC overlay system on normal weight concrete shall be 250 psi. An acceptable test will demonstrate that the overlay bond strength is sufficient by producing a concrete subsurface failure area greater than 50% of the test surface area. The contractor shall repair all bond test locations with polymer overlay in accordance with this specification.

(d) ***Smoothness Quality Testing:*** The finished transverse and longitudinal surface elevation of the pavement shall be measured using a 10 foot straightedge. Areas to be measured will be as directed by the Engineer. The Contractor shall furnish an approved 10 foot straightedge, depth gauge, and operator to aid the Engineer in testing the pavement surface.

519.14 Corrective Work.

(a) ***Repair of Surface Defects:*** The repair materials and finishing methods for surface defects in the overlay shall be in accordance to those used for the application of the overlay. All surface defects shall be repaired to the satisfaction of the Engineer before acceptance of the work is made.

(b) ***Correction for Smoothness:*** Areas showing high spots of more than 3/16 inch in 10 feet shall be marked and diamond ground until the high spot does not exceed 3/16 inch in 10 feet. Longitudinal tining shall be grooved to restore the longitudinal texture (tining).Areas showing low spots of more than 3/16 inch in 10 feet shall be marked and prepared with shot blasting or sandblasting, primed, and filled with either resin or mixed material. The use of resin or mixed material shall be as recommended by the System Provider and approved by the Engineer.

(c) ***Replacement of Defective Overlay:*** A defective overlay, or portion thereof, resulting in failing overlay pull bond test results shall be removed and replaced at the Contractor's expense. The Contractor shall submit a written corrective work proposal to the Engineer, which shall include the methods and procedures that will be used. The Contractor shall not commence corrective work until the methods and procedures have been approved in writing by the Engineer. The Engineers approval shall not relieve the Contractor of the responsibility of producing work in conformity with the Contract.

METHOD OF MEASUREMENT

519.15 Furnished overlay material will be measured by the actual volume of polyester concrete material complete-in-place. The volume shall include material used for patching unsound concrete and deck rehabilitation as directed by the Engineer.

Overlay placement will not be measured, but shall be the quantities specified in the plans for the final surface. Quantities for placement of patching areas will not be measured and paid for separately, but shall be included in the work.

Construction and removal of trial applications including concrete base surfaces will not be measured and paid for separately, but shall be included in the work.

BASIS OF PAYMENT

519.16 Thin Bonded Polyester Concrete Overlay will be paid at the unit price bid as follows:

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

Payment will be made under:

Pay Item	**Pay Unit**
Furnish Thin Bonded Overlay (Polyester Concrete)	Cubic Foot
Place Thin Bonded Overlay (Polyester Concrete)	Square Yard

Payment for Furnish Thin Bonded Overlay (Polyester Concrete) shall include all costs required to furnish the polyester concrete material, including freight, to the project site and dispose of any unused overlay material. Payment by CF will be based on 135 lbs. per CF.

Payment for Place Thin Bonded Overlay (Polyester Concrete) will be full compensation for all labor, equipment, and all incidentals necessary to prepare the concrete surface and complete the overlay placement.

Costs for placement of polyester concrete material in spalled and deck removal areas shall not be measured and paid for separately, but shall be included in the work.

The Contractor shall collect a ticket for each pass or portion of a pass that is provided by each mixer, and ensure that the following information is shown on each ticket:

(1) Project Number
(2) Bridge Number
(3) Date and Time
(4) Ticket Number
(5) Material Type
(6) Location of Placement (Lane and Station Limits)
(7) Aggregate Weight
(8) Polyester Resin Binder Weight

The tickets shall be available on site for CDOT personnel to inspect.

Each day the Contractor shall provide to the Engineer separate envelopes for each bridge which contains the previous day's signed tickets and the following:

(1) On each envelope: Project Number, Bridge Number, Date of Paving, Type of Material, Daily Total, Cumulative Total, and Suppliers Name.

(2) One of the following:
   A. Two adding machine tape tabulations of the weight tickets with corresponding totals run and signed by different persons,
   B. One signed adding machine tape tabulation of the weight tickets that has been checked and signed by a second person,
   C. Signed check tape of computer scale tickets that have a cumulative total. These scale tickets must be consecutive.

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SECTION 519
THIN BONDED OVERLAY (POLYESTER CONCRETE)

(3) A comparison of the actual yield for each day's placement to the theoretical yield. Theoretical yield shall be based on the actual area paved and the planned thickness of the mixture being placed. Any variance greater than 5% shall be indicated on the envelope and a written explanation included.

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REVISION OF SECTION 601
CLASS G CONCRETE

Section 601 of the Standard Specifications is hereby revised for this project as follows:

In subsection 601.02 add Class G to Table 601-1:

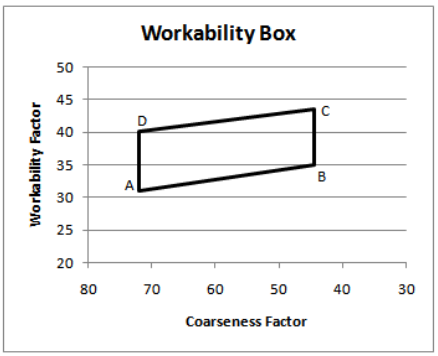
G	4,500 at 28 days	N/A	5 – 8	0.45

In subsection 601.02 add Class G Concrete:

Class G concrete is a low shrinkage macro-fiber reinforced structural concrete. Class G concrete may be substituted for Class B and Class D concrete. Additional requirements are:

(1) Shall include a minimum of 4 pounds per cubic yard of Macro Fiber-Reinforcement.
(2) Shrinkage reducing admixtures may be incorporated into the mix.
(3) The unrestrained shrinkage shall be less than 0.025 percent when tested by CP-L 4103.
(4) The permeability of the mix shall not exceed 2,500 Coulombs at an age of not more than 56 days as determined by ASTM C1202.
(5) If the mix contains more than 30 percent fly ash by weight of the total cementitious material, the salt scaling resistance of the trial mix shall be less than 3 as determined by ASTM C672.
(6) The mix shall have a nominal maximum aggregate size of ¾ of an inch if an optimized gradation is not used.
(7) The concrete mix may use an Optimized Gradation (OG). When an OG is used aggregate proportions must be a result of an optimized combined aggregate gradation (CAG) developed by an approved mix design technique such as Shilstone or KU Mix. The amount of aggregate in the CAG passing the 19 mm (¾ inch) sieve and retained on the12.5 mm (½ inch) sieve shall be a minimum of 8 percent for the trial mix design. The coarseness factor (CF) and workability factor (WF) must plot within the workability box (ABCD) depicted graphically by the following 4 coordinate points:
    a. Point A> (CF,WF) 72, 31
    b. Point B> (CF,WF) 44.5, 35
    c. Point C> (CF,WF) 44.5, 43.5
    d. Point D> (CF,WF) 72, 40

Figure 601-1



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REVISION OF SECTION 601
CLASS G CONCRETE

CF = (S / T) x 100
Where:
S = Percent Cumulative Retained on 9.5 mm (3/8 inch) Sieve
T = Percent Cumulative retained on 2.36 mm (No. 8) Sieve

WF is the percent passing the 2.36 mm (No. 8) sieve. Increase workability factor by 2.5 percentage points for every 94 pounds per cubic yard of cementitious material used in excess of 564 pounds per cubic yard in the mix design. Decrease workability factor by 2.5 percentage points for every 94 pounds per cubic yard of cementitious material used below 564 pounds per cubic yard in the mix design. The Contractor shall not adjust the workability factor if the amount of cementitious material is 564 pounds per cubic yard.

(8) An expansive cement additive may be added to an ASTM C150 Type I/II cement and fly ash to produce an ASTM C845 Type K cement. Approximately 15-20 percent by weight of the cementitious content of the concrete will be the expansive cement additive. The proportion of the expansive cement additive will be determined by testing the cementitious material blend in accordance with ASTM C806 The blended material shall have an expansion of 0.04 to 0.10 percent at 7-days when tested in accordance with ASTM C806.

When an expansive cement is used the w/cm ratio shall be 0.45 to 0.55, and the expansion of the laboratory trial mix shall be 0.05 to 0.09 percent at 7 days when tested in accordance with ASTM C878.

Subsection 601.05 shall include the following in the second paragraph:

(8) Concrete with an OG shall indicate the gradation proportions that results in a combined aggregate gradation corresponding to compliance within the specified CF and WF box and shall include the following charts used to perform aggregate gradation analysis:
(i) Coarseness Factor
(ii) Workability Factor
(iii) 0.45 power
(iv) Combined gradation

Delete Subsection 601.06 (10) and (11) and replace with the following:

(10) Weights of fine and coarse aggregates or combined weight when an OG is pre-blended
(11) Moisture of fine and coarse aggregates or combined moisture when an OG is pre-blended

Subsection 601.16 shall include the following:

(g) Class G concrete with an expansive cement shall be cured as follows:

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REVISION OF SECTION 601
CLASS G CONCRETE

Water Cure Method. The water cure method shall be applied as soon as it can be without marring the surface. The surface of the concrete, including bridge curbs and bridge sidewalks, shall be entirely covered with wet burlap and polyethylene sheeting. Prior to being placed, the burlap shall be thoroughly saturated with water. The wet burlap and polyethelene sheeting shall extend at least twice the thickness of the bridge deck beyond the edges of the slab and shall be weighted to remain in contact with the surface. The wet burlap and polyethylene sheeting shall remain in contact and be kept wet for the entire curing period

Subsection 601.17 shall include the following:

(g) W*ater to cementitious material content (w/cm) ratio.* For Class G concrete the maximum w/cm ratio is the w/cm ratio that was used in the in the laboratory trial mix for the Concrete Mix Design. The w/cm ratio shall be determined for each batch of Class G concrete by the Contractor and provided to the Engineer for approval prior to placement. If an adjustment to the mix is made after the Engineer's approval, the w/cm shall be determined and submitted to the Engineer prior to the continuation of placement. Any Concrete Class G concrete that is placed without the Engineer's approval shall be removed and replaced at the Contractor's expense.

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REVISION OF SECTION 601
FIBER REINFORCED CONCRETE

Section 601 is hereby revised for this project as follows:

Subsection 601.03 shall include the following:

Where Fiber-Reinforced Concrete is specified or designated in the plans, the concrete mix shall include approved polyolefin fibers. Unless otherwise specified, a minimum of 3.5 lbs per cubic yard of polyolefin fiber reinforcement shall be evenly distributed into the mix. Mixing shall be as recommended by the manufacturer such that the fibers do not ball up. Polyolefin fibers shall meet the requirements of ASTM C1116 and ASTM D7508.

Where Macro Fiber-Reinforced Concrete is specified or designated in the plans, the concrete mix shall include approved macro polyolefin fibers. A minimum of 4.0 lbs per cubic yard of macro polyolefin fiber reinforcement shall be evenly distributed into the mix. If less than 4.0 lbs. per cubic yard of macro polyolefin fiber reinforcement is used in the mix, the Contractor shall provide test results showing the mix design has a residual strength of 170 psi as determined by ASTM C1609. Mixing shall be as recommended by the manufacturer such that the fibers do not ball up. Macro polyolefin fibers shall meet the requirements of ASTM C1116 and ASTM D7508 with the following exceptions:

1. Tensile strength shall be a minimum of 65 ksi
2. Modulus of Elasticity shall be a minimum of 1,000 ksi
3. Cut length shall be 1.5 to 2.2 inches
4. Aspect Ratio shall be 50 to 100

Subsection 601.05 shall include the following:

When fiber reinforced concrete is specified in the contract, polyolefin fibers may be added to an approved mix design except when Macro Fiber-Reinforced Concrete is specified. If Macro Fiber-Reinforced Concrete is specified a new trial mix will be required. When polyolefin fibers are added to an approved concrete mix design, the Contractor shall submit a letter stamped by the Concrete Design Engineer approving the changes. The stamped letter shall include the following and will be approved by the Engineer prior to use:

1) The mix design number, both the CDOT mix ID number and the suppliers mix ID number
2) The brand and type of polyolefin fibers.
3) The dosage of polyolefin fibers in pounds per cubic yard.
4) Adjustment to the fine aggregate batch weight

Subsection 601.05 shall include the following:

(18) Weight of polyolefin fiber reinforcement

Subsection 601.19 shall include the following:

Polyolefin fiber reinforcement will not be measure and paid for separately.

REVISION OF SECTION 607
FENCE (SPECIAL)

Section 607 of the Standard Specifications is hereby revised for this project as follows:

Subsection 607.01 shall include the following:

Fence (Special) shall consist of 3 cables supported by pipe posts bolted to the tops of retaining walls as shown on the plans. Fence (Special) shall be 42 inches tall and the cables equally spaced.

Subsection 607.02 shall include the following:

Posts, and horizontal and diagonal members shall be standard or extra strong steel pipe, as noted in the plans, satisfying ASTM A53 Type E or S, Grade B (fy = 35 ksi). All fittings and connections dependent on the pipe's inside diameter shall be modified as necessary for proper fit-up, as approved by the Engineer.

Steel plate and bar steel shall conform to ASTM Grade 50 (fy = 50,000 psi).

Post tops, cable clamps, eye bolts, thimbles and other required fittings shall be high strength steel. All post tops shall be watertight. The eye of the eye bolts shall be either drop forged or formed with a full penetration weld, at the Contractor's option. The eye shall develop 100 percent of the bolt strength.

Turnbuckles shall be high strength and shall have jaw or eye ends as shown on the plans. Turnbuckles shall have a minimum breaking strength of 2,700 pounds. At the option of the Contractor, turnbuckles shall be steel pipe type or drop forged steel.

Crimped sleeve clamps and stop sleeve clamps shall be nonferrous metal, shall develop the strength of the cable, and shall be the color of the cable.

Cable shall be wire strand or rope with a minimum diameter of 1/4 inch and shall have a minimum breaking strength of 1,800 pounds. Cable shall be galvanized in conformance with the requirements in Federal Specification RR-W-410D.

Subsection 607.03 shall include the following:

The cables shall be tensioned to provide taut railings between posts. Cable must have a maximum deflection of 3 inches in any direction when a 200 pound load is appled. Provide 4 anchor bolts at each post location. Anchor bolts shall be designed to resist a 400 pound load applied in any direction at the top of the post.

Subsection 607.04 shall include the following:

Fence (Special) will be measured by the linear foot. Measurement will be along the base of the fence from center to center of the extreme end posts.

Subsection 607.05 shall include the following:

Payment for Fence (Special) will be full compensation for all work, materials, tools, equipment and incidentals required to construct the fence as reflected on the plans. This shall include the fence and all of its components including posts, diagonals, cable (wire) and post caps. This shall also include connecting features such as brackets, clamps, bolts, eyebolts, thimbles and turnbuckles as well as anchorages including plates, bar steel, bolts, anchor bolts, nuts, and washers.

END OF SECTION 15

16.0 TRANSPORTATION MANAGEMENT PLAN (TMP)

The Contractor shall conduct all Work necessary to meet the requirements associated with developing and implementing a Transportation Management Plan (TMP). The TMP will define the strategies for managing the work zone impacts of the project. The components of the TMP shall include a Maintenance of Traffic (MOT) plan, a Traffic Operations Plan (TOP) and shall incorporate the coping elements of the Public Information Plan.

16.1 Administrative Requirements

The Contractor shall comply with the requirements of the following manuals or most current version at time of advertisement and standards for the design and construction of the work of this section.

- 2009 MUTCD including Revisions 1 and 2
- ATSSA Quality Guidelines for Work Zone Traffic Control Devices
- 2012 CDOT M&S Standard Plans
- 2011 Standard Specifications for Road and Bridge Construction
- AASHTO Roadside Design Guide
- CDOT Roadway Design Guide
- 2015 CDOT Region 1 Lane Closure Strategy – Fourth Edition
- CDOT Guidelines for Developing Traffic Incident Management Plans for Work Zone
- CDOT Region 1 Detour Signing and Public Notification for Exit Ramp Closures
- The Colorado Supplement to the Federal Manual on Uniform Traffic Control Devices 2009
- CDOT Sign Design Manual – March 31, 2015
- FHWA Standard Highway Signs – 2004 Edition
- FHWA Standard Highway Signs – 2012 Supplement
- https://www.codot.gov/library/traffic/lane-close-work-zone-safety/work-zone-safety-mobility-program

16.1.1 Transportation Management Plan (TMP)

The Contractor shall prepare a Traffic Management Plan (TMP) which defines the strategic plan for traffic management on the Project. The TMP shall address major aspects of the Work for individual construction areas, phases, and stages as defined herein. These aspects shall include, but are not limited to; C-470 and ramp closures, bridge closures, interchange closures, local streets, construction phasing and staging, numbers and type of major traffic shifts, detours, typical section requirements, pull out requirements, emergency and construction access, pedestrian and trail impacts and detours.

Within 30 Days after NTP1 the Contractor will convene a TMP kick off meeting with CDOT and Local Agency representatives. The meeting will be used to develop agreement upon the level of detail required for the TMP as identified in this Section. The TMP is a planning and policy guide which shall be used by the Contractor to develop and execute the project MOT program.

The major aspects of the TMP shall include, but are not limited to:

1. An overview and description of the proposed construction, subdivided as applicable, into the following components:

   A. Area: A specific grouping of Work along the Project defined by the Contractor that creates segments of the Project for the purpose of planning and executing the Work.

   B. Phase: A specific sequence of the construction Work in an area during which a major traffic movement is undertaken (e.g., a detour) and left in place until the Work is complete and traffic is redirected to another location. This shall require development of a specific Traffic Control Plan (TCP). In some cases, multiple TCPs may be necessary.

   C. Stage: A subdivision of Work within a phase that combines similar components of Work to maintain efficiency.

2. A detailed approach to the development of TCPs and Methods of Handling Traffic (MHTs) on the Project

3. A list of known or potential roadway, ramp, and lane closures, including the following information

   A. Description of traffic shift

   B. Description of detour

      a. Specific routes used

      b. Identification of detour limits to be used in each construction phase.

      c. Contractors' identification and coordination with other construction projects, within the vicinity of the proposed detour route. The impact of these construction projects shall be incorporated into the detour route planning and scheduling.

   C. Number of shifts expected

   D. Duration of shifts and detours

4. An approach to Travel Demand Management (TDM) strategies

5. An approach to the use of Intelligent Transportation System/Variable Message Sign (ITS/VMS) boards and traffic signals, including coordination with the affected Local Agency's Traffic Management Center or the CDOT Traffic Management Center (CTMC), and the Contractor's representative.

6. The Contractor's plan for coordinating the TMP Activities with those Activities required under Book 2, Section 4 - Public Information.

A. A checklist identifying specific items that shall be provided both to the Contractor's Public Information Officer, the CDOT Public Information Officer and CDOT Traffic Management Center and CDOT R1 Traffic Engineer every Thursday by 10:30 a.m. for public information data collection and management activities on the Project. The checklist shall provide the inclusion of supporting information relevant to coping messages and public awareness and shall be included in the Public Information Plan (PIP) required in Book 2, Section 4.

7. Additional Elements

   A. An approach to coordination and cooperation with construction being performed by projects along C-470.

   B. Approach to coordination and cooperation with construction being performed by Utility Companies or other utility relocations, as required in Book 2, Section 7 - Utility Relocations.

   C. Approach to coordination and cooperation with construction being performed by local agency projects that are occurring on possible detour routes.

   D. An approach to traffic access management, including restrictions, bicycles, pedestrians, and potential impacts to handicapped mobility.

   E. Relevant portions of the Incident Management Plan (IMP), described below.

   F. An approach to special event coordination.

8. Typical section requirements

9. Emergency requirements

   A. Pull-out locations
   B. Emergency access
   C. Courtesy patrol

10. Temporary closure scenarios

    A. Location
    B. Time and Duration

11. Access

    A. Pedestrian/bike
    B. Business
    C. Work Site (area)
    D. Bus/Transit

12. Construction Zone Temporary Speed Reduction

Temporary speed reduction, if warranted, must be authorized by a Form 568 approved by the R1 Traffic Engineer. Temporary speed reduction may be authorized during the construction phasing of the Project when the following conditions exist:

A. Travel lanes are 11 feet and reduced shoulder widths of 2 feet with emergency pullouts are provided
B. Lane closures adjacent to live traffic
C. Traffic phasing where corridor geometrics restrict design speed to less than posted speed
D. Other safety concerns as documented by the Engineer

13. MHT Requirements

The Contractor shall use barriers to positively separate traveled lanes from work zones where construction clear zone requirements cannot be achieved. All work zone traffic control devices, barriers and crash cushions/impact attenuators shall meet NCHRP 350 Test Level 3 requirements.

14. Traffic Control Device Maintenance

An approach and commitment to clean traffic control devices in a timely manner after each storm that reduces reflectivity below required levels. Include equipment and staff commitments.

The TMP shall be submitted to CDOT (and the respective local agency(ies) where local streets are affected) for Acceptance prior to NTP2. No Work that impacts traffic shall commence until the TMP is Accepted.

16.1.1.1 Maintenance of Traffic (MOT) Program

The following elements must be considered as elements of the MOT program and will be addressed in the TMP.

16.1.1.1.1 Transportation Management Plan Task Force

The Contractor shall establish a TMP Task Force to assure proper coordination with affected agencies. The TMP Task Force shall include, at a minimum, the Contractor's Public Information Officer, Traffic Control Supervisor, Superintendent, CDOT, Douglas County, and Jefferson County (Littleton, Lone Tree, Highlands Ranch, Ken Caryl) and others as needed if agency facilities are impacted. The Contractor shall submit the proposed list of task force members to CDOT for Acceptance within 30 Days after NTP1.

The TMP Task Force shall meet weekly, and shall be an integrated element of the Public Information Plan (PIP).

In addition to regular TMP Task Force meetings the Contractor shall schedule and conduct TMP Task Force Meetings to present and discuss Contractor prepared narratives identifying processes and critical elements of all full closures and coordination activities.

Within 14 Days after Acceptance of the TMP Task Force members, the Contractor shall convene a TMP kick-off meeting. The meeting will be used to develop agreement upon the level of detail required for the TMP as identified in this Section 16.

16.1.1.1.2 Business and Private Access

The Contractor shall maintain public and private access to the local street system at all times.

TCPs and MHTs shall incorporate stakeholder information from the PIP, available surveys, and other pertinent studies relating to business and private access to the local street system and the highway facility. At a minimum, the Contractor shall communicate and document the following information relevant to business and private access:

1. Access points impacted by a particular construction phase or stage
2. All notifications of affected businesses and land owners
3. Schedule of closures and estimated durations
4. Site-specific access or delivery requirements for local businesses (deliveries, wide load vehicles, etc.)
5. Proposed mitigation efforts

16.1.1.1.3 Maintenance of Traffic Variance Process

The Contractor may request a MOT variance for any closure, detour, or other restriction beyond the specified limits defined herein. The following information shall be included in each MOT variance request:

1. Summary of the variance request
2. Justification for the variance request, including a list of the criteria that cannot be met and the reasons for not being able to meet the criteria
3. Public notification methods and schedule
4. List of affected emergency services and the schedule for notification
5. List of affected agencies or private owners and the method(s) and schedule for notification
6. Description of additional public information surveys to be performed, if required
7. List of any potential safety hazards to which the public may be exposed
8. Proposed revisions to the Accepted TCP or current MHT
9. Proposed duration of closure, detour, or phasing change for which a variance is requested

The Contractor shall allow CDOT a minimum of 14 Days for review and Approval of any MOT variance requests. The Contractor shall obtain Local Agency approval for detours utilizing non-State owned facilities. If Local Agency approvals are necessary, they shall be obtained prior to submittal of the MOT to CDOT.

16.1.1.1.4 Detour Routes

Unless otherwise specified, only state highways shall be used for detour routes. Local Agency routes available for use as detours must be Approved by the Local Agency. Detour routes shall be the shortest length feasible. Detour routes shall be video recorded prior to and after construction. Contractor, CDOT and a representative of the local jurisdiction shall be present for video recording. Any damage to the routes as a result of the use of the route shall be repaired by the Contractor in a time and manner as negotiated with CDOT, the local jurisdiction, and the Contractor.

16.1.1.1.5 Trail and Pedestrian Impacts

Existing trail systems, temporary trails, sidewalks, and pedestrian routes must be maintained at all times. The Contractor shall meet all requirements of ADA as specified in Book 1 Section 2.2, except for the C-470 Trail.

The following restrictions shall apply to existing trail systems in the vicinity of the Project:

1. No trail closures shall be allowed along or crossing C470 without approved detours.
2. Temporary trail detours will be allowed under the following conditions:
   A. PIP requirements shall be identified and appropriate public notifications provided.

16.1.1.2 Transportation Operations Program (TOP)

The transportation operations component will address the operations and management of the transportation system in the work zone impact area. The TOP will address the components described below.

16.1.1.2.1 Coordination with CDOT Traffic Management Center (CTMC)

Routine requests for use of the CTMC VMS boards shall be submitted to CDOT by 10:30 a.m. on Thursday of the week prior to when the VMS boards will be needed (Monday through Sunday of the following week). Requests for routine use of the VMS will be reviewed by noon Friday of the same week of the submittal. The Contractor shall coordinate directly with the CTMC following review by CDOT.

The CTMC is available to the Contractor to modify VMS messages 24 hours a day, 7 days a week, and may be contacted at (303) 512-5826.

The Contractor shall coordinate with CDOT and the CTMC for emergencies in accordance with the Accepted Incident Management Plan.

16.1.1.2.2 Incident Management Plan

The Contractor shall develop a detailed Incident Management Plan (IMP) as a companion to the TOP to manage traffic incidents and emergency operations on the project Site. The IMP shall, comply with the CDOT *Guidelines for Developing Traffic Incident Management Plans for Work Zones.*

At a minimum, the IMP shall include the following components:

1. Coordination with the Public Information Plan (PIP)
2. Incident detection and identification
3. Incident response
4. Incident site management
5. Incident clearance
6. Dissemination of traveler information regarding incidents
7. Courtesy patrol
8. Emergency services notification, including local area Police Departments, the Colorado State Patrol (CSP), local area fire departments, ambulance services, and any other emergency response providers.
9. Notification of local school districts about possible impacts to school bus routes, student drop-offs, and/or pedestrian facilities
10. Geographic and other special constraints
11. Available resources
12. Operational procedures

The IMP shall be submitted to CDOT for Acceptance no later than 30 Days after NTP2. No Work that impacts traffic shall commence until the IMP is Accepted.

16.1.1.2.3 Courtesy Patrols

The Contractor shall provide courtesy patrols within the Project limits as part of the implementation of the IMP. The following measures shall be required for the courtesy patrol element of the IMP:

a. Courtesy patrol coverage shall be on the C 470 Mainline, local roads, ramps, State Highways, United States Highways and other roads and Highways affected by the Construction Work within the Site and one mile beyond;
b. Service shall be within the Site and provided during the following times:

   Monday thru Friday, from 6:00 AM to 9:00 AM and 3:30 PM to 6:30 PM
   Saturdays and Sundays during Contractor work hours for C 470 ;

c. The courtesy patrol vehicle shall be a tow truck vehicle meeting U.S. Department of Transportation standards;
d. The patrol vehicle shall have a 5-gallon container of gasoline and a cellular phone for use by stranded motorists. One gallon of gasoline and phone service shall be provided at no cost to the stranded motorist;
e. The patrol vehicle shall be Colorado licensed, including Public Utility Commission licenses, and be an insured Class A tow truck with a minimum gross vehicle rating of 10,000 pounds, dual wheel chassis and four-ton recovery equipment rating. Flatbed "roll back" service trucks may be used in lieu of boom type wrecker trucks. Flatbed trucks must be equivalent in capacity to specified boom type trucks (excluding vertical lift) to safely handle the scope of work. The vehicle must meet all federal, state, and local requirements for operation of tow vehicles;
f. The courtesy patrol operator shall be in contact with the CTMC and the Contractor via cellular phone during all hours of courtesy patrol operation;
g. The courtesy patrol shall respond immediately upon discovery of a disabled vehicle; and
h. The courtesy patrol shall tow, at no cost to the vehicle operator, the disabled vehicle to a location identified in the IMP. Courtesy patrol hours shall be communicated as part of Contractor's coping messages.

16.1.1.2.4 Contractor Response Time

The Contractor shall have at least one employee on call, via cellular phone, that can respond to an incident within 30 minutes, 24 hours a day, 7 days a week. Upon arrival at the incident site, that employee shall assess the situation and immediately notify the appropriate personnel to implement the IMP. Upon notification of the incident, the Contractor shall immediately undertake actions necessary to restore traffic operations to the maximum extent practicable.

16.1.1.2.5 Special Events

The Contractor shall coordinate with CDOT and all other local agencies, along with the Public Information Officer as specified in Book 2 Section 4 to develop a list and schedule of special events within 30 days after NTP 1. The Contractor shall update the list as events are identified or scheduled. The special event calendar shall be a standing agenda item at the Maintenance of Traffic Task Force meetings.

The Contractor shall identify and implement necessary changes in Work progress to accommodate traffic to and from special events. No lane closures shall be permitted on the day of the event unless approved by CDOT. Work outside the travel lanes, ramps and shoulders will be permitted during special events.

16.1.1.2.6 Denver Regional Transportation District

The Contractor shall coordinate with Regional Transportation District to minimize any impacts to the Transit System including bus routes, station access, bus stop locations, and other transit services.

16.1.1.2.7 Coordination with Adjacent Projects

Other projects along C-470 may occur during the construction of this project. The Contractor shall coordinate with CDOT and their contractors to coordinate construction traffic and detour impacts and minimize simultaneous closures or impacts to adjacent or alternate routes.

16.1.1.2.8 Coordination with Adjacent Neighborhoods

No construction traffic will be allowed in residential neighborhoods adjacent to the corridor.

16.1.1.3 Public Involvement Plan (PIP)

The TMP shall reference the appropriate sections of the Public Involvement Plan and Crisis Communication Plan developed in accordance with Section 4.

16.2 Design Requirements

The Contractor's Professional Engineer in responsible charge of the MOT design shall prepare, Review, and Approve: field design changes; Released for Construction documents; and TCP and MHT plans.

16.2.1 Traffic Control Plans (TCP)

The Contractor shall prepare a TCP to control traffic on the Project. The TCP shall conform to the requirements specified herein and the CDOT Standard Specifications for Road and *Bridge* Construction and the most current version of the MUTCD. The TCP shall generally describe all lane and shoulder configurations, including widths, traffic control signing, pavement markings, traffic control devices, temporary signalization, construction access, construction parking, emergency access, work areas, and pedestrian/bicycle requirements necessary for each construction phase. Temporary traffic signals shall be installed in conformance with standards set forth in Book 2, Section 14, Signing, Pavement Marking and Signalization & Lighting.

The TCPs shall be submitted to CDOT for Acceptance 14 Days prior to implementation of the particular TCP.

Temporary Drainage Plans shall be submitted concurrently with each Traffic Control Plan (TCP) and any major revisions to the TCP in accordance with Section 12 Drainage.

Any major revision to the TCP, as determined by CDOT, shall require submission of a new TCP for Acceptance.

16.2.2 Method of Handling Traffic (MHT)

Temporary traffic signals, if determined necessary by the Contractor, shall be installed in conformance with standards set forth in Book 2, Section 14.

16.2.3 Design Vehicle

The design vehicle shall be as described in Book 2, Section 13, Roadways, Exhibit A.

16.2.4 Design Speed and Posted Speed

Minimum design and posted speeds for Work zones shall conform to Table 16.2. During construction, the Contractor may only post the work zone at 55 mph when travel lanes are 11 feet and reduced shoulder widths of 2 feet with emergency pullouts are provided.

Table 16.2
DESIGN AND POSTED SPEEDS FOR WORK ZONES

Location	Design Speed (mph)	Posted Speed (mph)
I-25 Mainline (Match Existing posted speed)	65	65
C-470 Mainline	55	55
Ramps and collector-distributor roads	25	25
Local Cross-Streets	35	35

* The Contractor shall provide existing design and posted speed whenever it can be reasonably maintained on the local system.

16.2.5 Minimum Lane and Shoulder Requirements

16.2.5.1 Lane and Shoulder Restrictions

The Contractor shall limit Construction Impacts to the durations allowed in Book 1, Section 17 of the Contract Documents. Construction Impacts are defined as any reduction in the number of required lanes or any reduction in the widths of required lanes and shoulders throughout the Project, including C-470, I-25, all cross-streets and associated ramps.

Before any travel lanes or shoulders are closed, the Contractor shall submit an appropriate MHT or TCP to CDOT for Acceptance. The MHT/TCP shall be developed in accordance with CDOT Region 1 Lane Closure Strategies and Local Agency guidelines.

Lane restrictions must be submitted to CDOT by the Contractor by Thursday 10:30 a.m. of the week in advance of the work (for work Sunday through Saturday), unless required by construction emergencies or other reasonably unforeseen events.

Minimum lane widths for travel lanes on C-470, I-25 mainline, and all cross-streets shall be 11 feet. Minimum outside shoulder widths on C-470 and I-25 mainline shall be 8 feet. Outside shoulder widths of less than 8 feet may be used, to a minimum shoulder width of 2 feet when emergency pullouts are provided. Inside shoulder widths shall be a minimum of 2 feet. Acceleration, deceleration and ramp lanes shall not be considered as through lanes.

Table 16.3
MINIMUM LANE WIDTHS

Location	Travel Lanes	Shoulders	
		Inside	Outside
I-25 Mainline	11	2	8*
C-470 Mainline	11	2	8*
Ramps and collector-distributor roads	11	2	2
Local Cross-Streets	11	N/A	N/A

* Narrower widths to a minimum of 2' allowed when emergency pullouts are provided

During all non-working hours the contractor shall maintain existing number of through lanes in each direction at all times on C-470 mainline. There shall be no reduction in the number of through lanes between construction phases - each phase of construction shall maintain at least the same number of through lanes as the previous phase of construction.

Allowable lane closures for the Project shall be in accordance with the Region 1 Lane Closure Strategy until Notice of Final Acceptance, regardless of the number of in service through lanes, auxiliary lanes, or shoulders.

When travel is reduced to a single lane in one direction, the Contractor shall provide a minimum clear width of 16 feet to accommodate oversize vehicles.

16.2.5.2 Lane Closures

Before any lanes are closed, an appropriate MHT shall be Approved by the Contractors Professional Engineer and Accepted by CDOT. Lane closures must be submitted and Accepted by CDOT at least 5 working days in advance of the closure, unless required by construction emergencies or other reasonably unforeseen events.

16.2.5.3 Ramps and Local Roads

Minimum lane widths for ramps shall be 11 feet and shall accommodate a truck turning movement of a WB-67 design vehicle. Minimum shoulder width is 2 feet. Temporary ramp terminals shall be designed as parallel type.

Any and all variances for Local Street lane closures and lane reductions shall be Approved by the respective jurisdiction. Acceleration and deceleration lanes shall be provided for all temporary ramp configurations. Any and all variances shall be approved by CDOT as an MOT variance request.

16.2.5.4 Emergency Pullouts

The Contractor shall provide emergency pullouts on C-470 for disabled vehicles, staging of incident management, and law enforcement vehicles when shoulder widths are less than 8 feet. Emergency pullouts shall be provided a minimum one-half mile from the upstream on-ramp gore when the gore to gore distance of successive on and off ramps is ¾ mile or greater. The same spacing is required when the distance from the end of the return taper of the pullout and the downstream off ramp gore is ¾ mile or greater. The minimum pullout length shall be 150 feet, not including transitions. Transitions shall be made at 15:1 or greater. The minimum pullout width shall be 12 feet measured from 2 feet beyond the travel lane. The pullouts shall be signed for emergency parking only, shall have a paved surface, shall include advance signing in compliance with the Manual on Uniform Traffic Control Devices (MUTCD), and shall not be subject to ponding or other weather-related conditions that could render them unsafe or ineffective.

16.3 Construction Requirements

The Contractor shall provide installation, maintenance, and removal of all temporary traffic control devices.

16.3.1 Temporary Traffic Control Devices

16.3.1.1 Construction Signing

Construction signing within the Project limits and all detours shall comply with CDOT *Standard Specifications*, the MUTCD and all other applicable standards set forth herein. The Contractor shall maintain all existing guide signs, warning signs, and regulatory signs during construction. Construction signing and construction signing maintenance shall be the responsibility of the Contractor.

All signs in place for more than three (3) days shall be post mounted.

16.3.1.2 Temporary Traffic Signals

Temporary traffic signals (including Ramp Meters), if determined necessary by the Contractor, shall comply with Book 2, Section 14, Signing, Pavement Marking, Signalization & Lighting. The Contractor shall operate the temporary signals and respond to malfunctions during the duration of the project. Temporary signal timing shall be designed and submitted to CTMC and CDOT R1 Traffic Engineer 14 days prior to implementation for their approval. Maintenance of the temporary signal(s) shall be the responsibility of the Contractor.

16.3.1.3 Temporary Marking Paint and Signs

The Contractor shall furnish, apply and remove temporary pavement marking paint in accordance with CDOT *Standard Specifications*. Temporary paint striping shall meet the conformity of lines (including no overspray), dimensions, patterns, locations and details established in the Contractor's TCP and MHT.

1. Temporary pavement paint striping shall be re-striped once a month, or as required to maintain safe traffic operations.
2. Epoxy-based paint shall not be allowed on concrete pavement surfaces for temporary striping.
3. Hydro blasting, or other methods that do not result in scaring of permanent pavements shall be used for removal of temporary striping.

Barrier reflector strips shall be installed on all temporary barrier when barrier is within 4 feet on the traffic, as per the CDOT Standard S-612-1. The spacing between each three foot panel shall be no more than 50 feet.

Delineators shall be used throughout the Project, including lighted areas

16.3.1.4 Glare Screens

Glare Screens shall be designed and installed on all opposing traffic permanent median barrier within the project construction limits on C470. Glare screens shall be in accordance with CDOT Standard M-606-13

Glare screen shall be designed and installed on all opposing traffic temporary barrier through sections where opposing traffic lanes are shifted.

The Contractor is required to install glare shields in all cross overs unless an evaluation of the crossover geometry determines that the glare shields are not applicable at that location.

All work zone traffic control devices shall meet NCHRP 350 Test Level 3 requirements.

16.3.2 Maintenance of Temporary Traffic Control Devices

The Contractor shall be responsible for the maintenance of all temporary traffic control devices within the Project limits, including the local street system. All traffic control devices shall meet MUTCD requirements including retroreflectivity standards and shall also meet the acceptable standard as defined by the ATSSA Quality Guidelines for Work Zone Traffic Control Devices.

16.3.3 Detour Pavement

The Contractor shall provide a paved surface for all detours. Design and construction of detour pavement shall also conform to the requirements of Section 10 Geotechnical and Roadway Pavements. Detour pavement locations shall be generally described in the Contractor's TMP and detailed in the Accepted TCP.

The Contractor shall maintain the detour pavement for the entire period that it is open to the traveling public, including all temporary approaches, accesses, crossings, and intersections with adjacent roads and streets. Detour pavements shall be maintained in good operating condition devoid of potholes, uneven surfaces, and rutting. CDOT may direct the Contractor to repair or replace detour pavements if, in CDOT's sole discretion, detour pavements are determined to be in poor condition. Detours that use existing streets pavements shall be subject to pavement repair or replacement where it is determined that the condition of the existing pavement has

noticeably deteriorated over the duration of its use as a detour. The Contractor shall obtain written approval from the affected Local Agency prior to use of any local streets for detours.

The Contractor shall be responsible for the complete removal and disposal of all temporary detour pavement.

16.3.4 Temporary Lighting

The Contractor shall maintain temporary lighting at a level equivalent to existing lighting provided within the Project Limits, including C-470 and I-25 mainlines, ramp gores, ramp intersections and local streets.

16.3.5 Queue Delays During Construction

The Contractor shall monitor queue lengths and durations on all roads within the Project limits whenever a lane closure is in effect. If the queue times exceed 15 minutes the Contractor shall notify CDOT and adjust the detours, lane closures, traffic control devices, including advanced signing, to minimize delay. If queue lengths extend beyond advance warning the Contractor shall adjust the detours, lane closures, traffic control devices, including advanced signing, and provide advance warning to motorists, of stopped traffic.

16.3.6 Working Time Violations Incidents (WTVI)

If there is a violation of the working time limitations for traffic control as allowed for in this Section 16, price reductions will be assessed and a written notice to stop Work will be imposed on the Contractor at the start of the next Working Day. Work shall not resume until the Contractor assures CDOT, in writing, that there will not be a reoccurrence of the working time violation. The WTVI price reduction charges shall be reflected on the Contractor's monthly invoice. Price reductions will not be considered a penalty, but will be a price reduction for failure to perform traffic control in compliance with the Contract.

A WTVI is any violation up to 30 minutes in duration. Each 30 minutes or increment thereof will be considered as a WTVI. A price reduction will be assessed for each successive or cumulative 30-minute period in violation of the working time limitations, as determined by CDOT.

WTVI charges shall be as follows:

1. C-470 (mainline and ramps) - $4,600 per WTVI
2. I -25 (mainline and ramps) - $4,600 per WTVI
3. US-85 - $1,750 per WTVI
4. All local street WTVI charges will be consistent with the Local Agency policy

16.4 Deliverables

The Contractor shall submit the following to CDOT (and Local Agencies when applicable) for review, Approval, and/or Acceptance:

Deliverable	Acceptance, or Approval	Schedule
Transportation Management Plan (TMP)	Acceptance	Prior to NTP2
TMP Task Force Members	Acceptance	Within 30 Days after NTP1
Requests to CDOT CTMC and Local Agencies for modifications to traffic signals, timing, and VMS messages	Approval	14 Days prior to the requested date for modifications
Incident Management Plan (IMP)	Acceptance	Within 30 Days after NTP2
MOT variance request	Approval	14 Days prior to the requested date for the change
Traffic Control Plan (TCP)	Acceptance	At least 14 Days prior to implementation of the TCP
Method of Handling Traffic (MHT)	Acceptance	At least 5 Working Days prior to implementation of the MHT requiring a lane closure

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

17.0 Landscaping

Structure aesthetics, including bridges, retaining walls, and noise walls, are provided in the Project Aesthetic Plans in Book 4.

17.1 Design Requirements

17.1.1 Landscape Plan

The Contractor shall prepare a Landscape Plan for all existing plant material in all disturbed areas on the Project. The Landscape Plan shall address both temporary and permanent work. The Landscape Plan shall include the areas to be final seeded and the locations, mitigations, removals, and replacements of Project-impacted trees, shrubs, landscapes and irrigation.

The Landscaping Plan shall be required for any area of the Work where construction disturbance occurs including permanent Right-of-Way (ROW), temporary easements, staging, haul road, locations of borrow, or other areas that are disturbed as part of the Project or Work.

The Landscape Plan shall identify the locations of protected areas. The Contractor shall save, protect, and maintain all existing vegetation in the Project except for the vegetation that must be removed to accommodate construction of the Project. All construction operations shall be performed in such a manner that will avoid these protected areas.

The Landscape Plan shall be developed in conjunction with erosion control requirements, as defined in, Section 12 Drainage, of the Contract. The Landscape Plan shall be phased to promote the protection of existing vegetation and working-an-area-to-completion for final stabilization.

The Landscape Plan shall document the vegetation location and identification. This shall include species, location, condition, size, health, and a recommendation for remaining undisturbed, pruning, removal, transplanting, or replacement.

The Landscape Plan shall include photo documentation of the vegetation, including grass coverage for the extent of the Project limits.

The Landscape Plan shall include the proposed locations of replacement or proposed locations of transplanted vegetation within Project boundaries.

The Landscape Plan shall make recommendations for replacement tree species based on the species and conditions as outlined by the State of Colorado portion of *The Roadside Use of Native Plants*, August 2000 USDOT, FHWA publication as edited by Bonnie Harper-Lore and Maggie Wilson.

All non Colorado Senate Bill 40 (SB 40) trees removed shall be replaced within the Project boundaries on a 1:1 basis. Replacement species shall match existing except for Elms, Russian Olive, or other invasive or noxious weed species. The Contractor shall comply with Local Agency planting requirements for both size and species for trees impacted or planted on local agency property.

Tree replacements within the existing US Army Corps of Engineers easement shall be replaced on a 1:1 basis within the easement, and as Approved as part of the Section 408 process provided in Book 2, Section 5. In riparian areas, removed native trees at least two inches in diameter must be replaced on a 1:1 basis on-site. In non-riparian areas removed trees at least four inches in diameter must be replaced on a 1:1 basis.

No plantings shall include any noxious weed species.

Replaced materials shall comply with Section 214 of the *Standard Specifications* and be equal or better to the existing materials in type and function.

Project impacted trees/shrubs within a riparian area (i.e., SB 40 trees and shrubs) shall be mitigated in accordance with Section 5, Environmental Requirements, of the Contract.

The Landscape Plan shall identify the landscape and irrigation systems impacted by the Project, including ownership by CDOT and/or Local Agency.

The Landscape Plan shall include a schedule of when Work shall take place.

No new irrigated landscaping is required for the project. Where existing irrigation systems are impacted by the Work, the Plan shall include layout, design, and specifications of irrigation system components, consistent with CDOT or Local Agency details of the existing system.

A watering schedule listing the Calendar Days chosen to complete the required watering shall be included as part of the Landscape Plan to facilitate reviews by CDOT. A field review shall be necessary as part of the Acceptance of the Landscape Plan.

The Contractor shall prepare and submit drawings and narrative as part of the Landscape Plan.

The Integrated Noxious Weed Management Plan, described in this Section 17, shall be included in the Landscape Plan.

All work shall be completed and stamped by a registered landscape architect in the State of Colorado.

17.1.2 Seeding

All disturbed areas within the Right-of-Way that are not surfaced shall be revegetated to replicate or enhance native vegetative communities.

All areas to be seeded shall be accessible to maintenance activities by CDOT. The Contractor shall provide a minimum of a 15-foot opening for access by maintenance vehicles.

Native grass seed mix shall contain low growing or slow growing, cool and warm season grass seed mix appropriate for the Colorado, Denver metropolitan area and as per CDOT's Policy Directive 503 for landscaping with native grass material. Riparian seed mix shall contain the native grass seed mix and appropriate riparian species. Noxious weeds and revegetation species that attract wildlife to the roadside area shall not be used. The proposed native seed mix and riparian seed mix shall be included in the Landscape Plan.

Slopes in detention facilities shall be planted with a grass mix that has been successfully implemented on other CDOT projects.

17.1.3 Integrated Noxious Weed Management

The Contractor shall use industry standard protocol for weed management, including the development of an Integrated Noxious Weed Management Plan (INWMP) to mitigate the potential adverse effects of earth disturbance. Noxious Weeds lists from CDOT, the State of Colorado, and the Local City and County shall be used.

The INWMP shall incorporate appropriate methods, such as herbicides, mechanical removal, and (potentially) biological controls. Appropriate control methods shall be selected carefully, especially in sensitive areas, such as wetlands, riparian and habitat corridors.

Noxious weeds shall be spot sprayed. In locations where spot application is not practicable, a wildlife biologist will inspect the area prior to spraying to ensure crucial habitat will not be impacted. The INWMP is further described in Book 2, Section 5 - Environmental.

17.2 Construction Requirements

17.2.1 Landscape Plan

Once the Landscape Plan is Accepted, the Contractor shall clearly tag all existing plant material that will remain undisturbed, pruned, removed or transplanted per the Accepted Landscape Plan and prior to the start of all construction activities. The Contractor shall also conduct a landscape walkthrough with the CDOT Landscape Architect prior to the start of construction. After Acceptance of the walkthrough, plant material shall be transplanted to areas, protection installed and pruning finished, as Accepted in the Landscape Plan and walkthrough. Removals may take place over the life of the Project.

17.2.2 Clearing and Work Area Limits Identification and Protection

The Contractor shall delineate the clearing and work limits in areas adjacent to existing wetlands, trees, and significant vegetation for Acceptance by CDOT. These areas shall adhere as closely as possible to the demolition/clearing and grubbing/selective thinning areas shown on the Landscape Plans provided in the Project Aesthetic Plans. Upon Acceptance, the Contractor shall install temporary orange fencing in these areas to identify the clearing boundary. The Contractor shall flag those trees adjacent to the boundary that are to remain in place. The Contractor shall use all appropriate care to avoid damage or removal of the flagged trees. Flagged trees that are damaged shall be replaced in-kind at the Contractor's expense. Trees that are damaged and assessed as salvageable shall be promptly repaired, pruned, wrapped, and protected from further damage at the Contractor's expense. All replacement trees and shrubs shall be native species per the State of Colorado portion of FHWA's *The Roadside Use of Native Plants*, August 2000.

The Contractor shall repair or replace in-kind all landscape material and vegetation that is disturbed by the Work. Replaced materials shall be equal or better than the existing materials in size, type and, condition. Revegetation plans for these areas shall be coordinated with the maintaining entity.

The Contractor shall repair, replace, relocate, or adjust all irrigation system components that are disturbed by the Work. Replaced materials shall be equal or better than the existing materials in type and function. Irrigation system modifications for these areas shall be coordinated with the maintaining entity.

17.2.3 Protection Areas

The Contractor shall install temporary fencing for the protection of all existing vegetation that is designated to remain undisturbed, for Acceptance by CDOT. Fencing shall be placed at twice the drip line for trees. The Contractor shall use all appropriate care to avoid damage or removal of the tagged trees. Tagged trees that are damaged shall be replaced in-kind at the Contractor's

expense. Trees that are damaged and assessed as salvageable shall be promptly repaired, pruned, wrapped, and protected from further damage at the Contractor's expense.

Construction activities, such as earth disturbance, storage, staging, or parking inside the drip line shall be prohibited. No chemicals shall be applied or used around or near these areas that would be detrimental to vegetation health.

The Contractor shall immediately report damage to any tree within the Work area designated to remain undisturbed, to CDOT, for assessment of the damage and survivability. Trees that are damaged which, at the sole discretion of CDOT, are determined will not survive, shall be replaced at the Contractor's expense. Trees that are damaged and are assessed as salvageable shall be promptly repaired, pruned, wrapped, and protected from further damage at the Contractor's expense.

Irrigated areas to remain shall be designated in the Landscape Plan and secured to prevent access for parking, staging, or other related Work elements, to ensure there is no damage to the system.

17.2.4 Trees and Shrubs

17.2.4.1 Removal of Trees and Shrubs

Tree stumps within the roadway prism or within 10 feet of the edges of roadway pavements shall be completely removed and disposed of off the Project Site. All other tree stumps within the Project shall be ground 3 feet below finished grade.

All trees or shrubs removed from the Project shall become the property of the Contractor and shall be completely disposed of off-Site by the Contractor.

17.2.4.2 Tree and Shrub Transplanting

The Contractor may transplant trees (SB 40 and non-SB 40) and shrubs (SB 40) impacted in existing landscaped areas to adjacent landscaped areas. The Contractor shall coordinate with CDOT and maintainers of existing landscaped areas to determine if transplanting trees or shrubs is desired. Transplanting shall not take place in those times where it is detrimental to the plants health. Evergreen species shall not be transplanted in the fall.

Trees and shrubs not transplanted shall be replaced on a 1:1 basis in adjacent landscape areas. Native trees removed in riparian areas with a diameter of at least two inches must be replaced on site on a 1:1 basis. Trees four inches or more in diameter removed from non-riparian areas must be replaced within the project limits.

17.2.4.3 Pruning

The Contractor shall have all root and branch pruning that interfere with the Work completed by a licensed and certified tree surgeon.. All Work shall be in accordance with American National Standard Institute – ANSI A300-1995, Section 5.3.3.2.

Root Pruning: Tree roots 2 inches or greater in diameter shall not be removed. The Contractor shall not prune roots at a depth greater than the excavation.

Branch Pruning: The Contractor may prune branches that will interfere with the Work per the Approved Landscape Plan.

The Contractor shall remove weak or dead branches on trees that are to remain within the ROW.

17.2.4.4 Planting Locations

The Contractor shall place replacement trees and shrubs according to the following:

1. Trees and shrubs impacted at existing formal landscaped areas shall be replaced at the same area or in same general vicinity as Approved by CDOT and owning or maintaining agency.
2. Shrubs not in formal landscape areas and non SB 40 shrubs do not require replacement.
3. Trees and shrubs impacted at existing riparian areas shall be replaced per SB 40 requirements.
4. Non SB 40 trees and non-formal landscape area trees shall be replaced as follows:
    a. Furnish replacement trees to CDOT landscape maintenance crews, with Approval from CDOT.
    b. Furnish replacement trees to adjacent Local Agency for planting in a local park, with Approval from CDOT and the Local Agency.
    c. Furnish replacement trees to the USACOE and/or Chatfield State Park for planting in the park.

17.2.5 Replacement Plant Material

The Contractor shall provide the following minimum tree sizes for trees to be planted or provided as part of the Work:

1. Deciduous trees: 2-inch caliper
2. Evergreen trees: 8 feet in height
3. For Formal Landscaped Areas
    a. Deciduous shrubs: 5 gallon
    b. Evergreen shrubs: 5 gallon
    c. Ornamental grasses: 1 gallon
4. SB 40 shrubs shall follow the SB 40 requirements.

All trees shall be balled and burlapped in accordance with M-Standard M-214-1 and Section 214 of the Standard Specifications. The Contractor shall be responsible for delivery and storage of trees per Section 214 of the Standard Specifications. Trees shall be protected from damage and deterioration during delivery and storage.

Trees will not be Accepted if the ball of earth surrounding the roots is cracked or broken during delivery and planting. Plants that have been cut back from a larger size to meet specifications (not the specified size), were improperly pruned, or have disease or insect infestation, shall not be Accepted.

All replacement tree/shrubs shall receive wood chip mulch per M-Standard M-214-1 and Section 213 Mulch of the Standard Specifications.

17.2.6 Staking and Watering

New replacement and transplanted trees shall be guyed in accordance with M-Standard Plans M-214-1 and Section 214 of the Standard Specifications. Trees shall be staked for two growing seasons. Guying material shall be removed at completion of the establishment period by the Contractor. Plants should be fully established at the end of three years.

The Contractor shall water new, transplanted, and protected trees on the Project until the Project has completed the establishment period. The Contractor shall water the plant material once a week at the rate of 50 gallons per tree per watering for the months May through October, and shall be watered twice per month at the rate of 70 gallons per tree for the months November through April, or as needed.

17.2.7 Topsoil

All topsoil, either imported or salvaged on Site, shall be treated with an herbicide for noxious weeds prior to final seeding.

17.2.8 Seeding

Placement of soil conditioner, topsoil, seeding, mulching (weed free), and mulch tackifier (or soil retention blanket) shall not be done in a single operation, but shall be completed immediately following each area that is to final grade per Standard Specifications 101, 107, and 208.

Fertilizer shall not be used adjacent to wetlands and waterways.

Seeding shall be drilled .25-inch to .5-inch into the soil. In small areas not accessible to drill, the Contractor shall hand-broadcast the seed at double the rate and rake into the soil .25-inch to .5-inch per Section 212 of the Standard Specifications.

Hydromulching is an acceptable method of stabilization. Hydroseeding shall only be allowed as Accepted by the CDOT Landscape Architect. Hydroseeding and hydromulching shall not be done in the same slurry.

All native and riparian seeding areas shall be drill seeded, mulched and mechanically crimped with weed free hay, and covered with an organic tackifier per Section 213 of the Standard Specifications.

Soil retention blanket shall be used for slopes steeper than 3:1. If soil retention blanket is used, mulching (weed free) and mulch tackifier are not required. Turf reinforcement mats shall be used in swales steeper than 2%. Soil retention blankets shall be per Section 216 of the Standard Special Provisions.

The Contractor shall place native seed, mulch (weed free), and mulch tackifier after each construction phase and prior to any winter shutdown Work.

Native seed areas shall contain a minimum of 90 percent grass species and no noxious weeds. Native seed areas shall have 80 percent coverage prior to Project Final Acceptance. Any native seed areas having poor germination (less than 80 percent coverage) shall be reseeded until establishment is reached. No bare spots greater than 6 feet by 6 feet shall be accepted.

17.2.9 Landscaping Inspection, Establishment, Acceptance, and Warranty Period

17.2.9.1 Interim Landscape Inspections

The following inspection points shall be completed and the Work shall meet the requirements of the Contract Documents prior to proceeding:

1. Completion of the subgrade preparation
2. Completion of finished grade preparation
3. Layout of planting beds
4. Layout of all plant materials
5. Completion of irrigation systems
6. Completion of planting operations

Nonconforming Work shall be replaced or repaired promptly by the Contractor at its own expense. When damage endangers public safety, or traffic, remedial action shall be taken immediately to ensure safety and prevent further disruption of traffic.

17.2.9.2 Substantial Landscape Completion

Substantial Landscape Completion is defined as when all plant materials (including seeding) have been planted and all irrigation items are completed in compliance with the requirements of the Contract Documents. Plants shall be healthy and in flourishing condition and be free of dying branches and branch tips, and shall bear foliage of normal density, size, and color. All mulch beds shall be completely mulched.

Prior to Substantial Landscape Completion, a landscape inspection shall be held with CDOT to determine Acceptance of plant material, seeding areas, and irrigation systems. Upon Acceptance CDOT will issue a “Notice of Substantial Landscape Completion.”

17.2.9.3 Landscape Establishment

The Landscape Establishment Period will commence at Project Final Acceptance which will be contingent upon receipt of a written “Notice of Substantial Landscape Completion” from CDOT in accordance with the requirements of Section 214 of the Standard Specifications and herein. The Landscape Establishment Period will last for 12 months, and will begin the following spring if Project Final Acceptance is issued in the fall.

All landscape installations shall be completely maintained by the Contractor during the Landscape Establishment Period. The Contractor shall submit a detailed Landscape Maintenance Plan in accordance with the requirements of Section 214 of the Standard Specifications and prior to requesting Project Final Acceptance. CDOT will inspect the landscape installations on at least a monthly basis to determine the acceptability of the maintenance Work. Nonconforming maintenance will be brought up to acceptable levels within 5 Days of receipt of notice of maintenance deficiencies.

17.2.9.4 Landscape Acceptance

Upon completion of the Landscape Establishment Period, at the Contractor's request, CDOT will inspect the landscaping to determine compliance to the requirements of the Contract Documents. All landscape installations shall be fully established, weed-free, clean, smooth, properly graded, and without plant mortality to be Accepted. The Landscape Establishment Period and Contractor maintenance will terminate after Landscape Acceptance is reached. Should CDOT identify any areas of Nonconforming Work, the Contractor shall correct the deficiencies and extend the Landscape Establishment Period for one additional growing season at no additional cost to the Project. If Landscape Acceptance occurs in the fall, the Contractor shall continue to maintain the landscaped area (including irrigation system) until the following spring. Any dead plant material or any damaged irrigation components shall be replaced or repaired at no additional cost to the Project. The Contractor shall perform a spring startup on the irrigation system, at no additional cost to the Project, ensuring all irrigation components are in working order.

17.2.9.5 Landscape Warranty Period

All trees, shrubs, and ground covers shall be completely warranted by the Contractor for one calendar year from the date of Landscape Acceptance. Any plant material deemed deficient following this one-year warranty period shall be replaced in-kind by the Contractor at no additional cost to the Project, and shall be warranted for one additional year by the Contractor. Any additional one-year warranty period beyond the initial one-year warranty period will be considered an extended warranty period. Another inspection will be conducted at the request of the Contractor at the end of the extended warranty period to determine Acceptance or rejection.

If access to a completed landscaped area is required by the Contractor after Landscape Acceptance, landscape materials will be considered existing and shall be protected in accordance with the requirements of the Contract Documents.

Trees or shrubs transplanted at CDOT's direction are not required to be warranted.

17.3 Project Special Provisions

The following specifications modify and take precedence over the CDOT *Standard Specifications*.

REVISION OF SECTION 107 - PROTECTION OF EXISTING VEGETATION

Section 107 of the *Standard Specifications* is hereby revised for this Project as follows:

Subsection 107.12 shall include the following:

The Contractor shall save all existing cottonwood trees in this area, except for that vegetation, which must be removed to accommodate construction of the Project, per the plans. Specific areas of vegetation to be protected shall be as directed by the Engineer and shall be protected by using orange construction fencing, wire fencing with metal posts or silt fence. Fencing for trees shall be installed at twice the drip line of the tree or as approved by the Engineer. Equipment shall not be installed or stockpile material placed within 15 feet of existing trees to remain.

The Contractor shall perform all the work in such a manner that the least environmental damage will result. All questionable areas or items shall be brought to the attention of the Engineer for approval prior to removal or any damaging activity.

The Contractor shall promptly report any vegetation damaged or scarred during construction to the Engineer for assessment of damages. Damaged or destroyed fenced vegetation, shall be replaced at the expense of the Contractor. Vegetation of replaceable size shall be replaced at the Contractor's expense. When trees beyond replaceable size or wetlands (other than the stretch of Fountain Creek that is to be reconstructed) have been damaged or destroyed, the Contractor shall be liable for the appraised value based upon the official current publications. For trees and shrubs use the International Society of Arboriculture, Guide for Plant Appraisals. The Contractor shall pay any fines or jail time should a wetland be damaged, at no cost to the Project. The value of disturbed vegetation shall be determined according to the vegetation size, species, location and existing condition.

A consulting Arborist retained by the Department will determine the value of the trees and shrubs. A consulting Wetland Specialist shall determine the value of the wetland or wetland species. This value will be deducted from any money due to the Contractor.

The determination as to whether a plant is of replacement size or beyond will be made by the CDOT Landscape Architect or Wetland Specialist.

If the fence is knocked down or destroyed by the Contractor, the Engineer will suspend the work, wholly or in part, until the fence is repaired to the Engineer's satisfaction at the Contractor's expense. Time lost due to such suspension will not be considered a basis for adjustment of time charges, but will be charged as contract time.

REVISION OF SECTION 202 - REMOVAL AND TRIMMING OF TREES

Section 202 of the Standard Specifications is hereby revised for this Project as follows:

Subsection 202.02 shall include the following:

This work includes the removal and the trimming of trees as directed by the Engineer. This work includes the preservation from injury or defacement of all vegetation and objects designated to remain.

The Engineer will establish environmental limits. All trees, shrubs, plants, grasses, and other vegetative materials shall remain, except as designated by the Engineer.

Prior to beginning any Bridge construction, removal, trimming, and pruning of encroaching vegetation (as determined by the Engineer) shall be completed.

Once all directed clearing, trimming, and pruning is completed and accepted, no additional clearing, trimming, cutting, or pruning will be allowed unless approved, in writing, by the Engineer.

This work shall be done by a Contractor or subcontractor who is a qualified tree surgeon and a member of the National Arborist Association. The firm's or individual's name and qualifications shall be submitted at the preconstruction conference for the Engineer's approval. A list of references and other clients shall be included with the qualifications statement. A written description of work methods and time schedules shall be submitted and approved in writing by the Engineer prior to work commencing.

Trees shall be felled at the risk of the Contractor. Strict limits of disturbance will be defined and shall be adhered to.

Branches on trees or shrubs shall be removed as directed by the Engineer. All trimming shall be done by skilled workmen. All work shall be done according to the following

requirements:

1. Pruning shall be done with proper, sharp, clean tools in such a manner as to preserve the natural character of the tree.

All final cuts shall leave no projections on or off the branch and shall not be cut so close as to eliminate the branch collar.

2. To avoid bark stripping, all branches 2 inches in diameter and larger shall be cut using the 3-cut method. These branches shall be lowered to the ground by proper ropes.
3. Tools used on trees known or found to be diseased, shall be disinfected with alcohol before they are used on other trees.
4. Structural weaknesses, decayed trunk or branches, or split crotches shall be reported to the Engineer.
5. When cutting back or topping trees, the Contractor shall use the drop-crotch method and avoid cutting back to small suckers. Smaller limbs and twigs shall be removed in such a manner so as to leave the foliage pattern evenly distributed.
6. When reducing size (cut back or topping) not more than one-third of the total area shall be reduced at a single operation.
7. Climbing spikes shall not be used on trees not scheduled for removal.

All brush, branches, limbs, and foliage smaller than 3 inches in diameter shall be chipped into mulch and stockpiled at a designated site. The trunks and limbs 3 inches and larger shall be cut into less than 6 foot lengths and hauled to a designated site..

Subsection 202.12 shall include the following:

Chipping, stockpiling mulch, and hauling and stockpiling trunks and limbs will not be paid for separately but shall be included in the work. Removal of trees will not be paid for separately but shall be included in the work.

All clearing and grubbing will not be paid for separately but shall be included in the work.

REVISION OF SECTIONS 207 AND 212 - TOPSOIL

Sections 207 and 212 of the Standard Specification are hereby revised for this Project as follows:

Subsection 207.01 shall include the following:

This Work includes importing or salvaging on site topsoil that is to be placed on disturbed areas within the Project.

Subsection 207.02 shall include the following:

The source of topsoil for this Project is undesignated. Topsoil is subject to Acceptance by CDOT before use. The Contractor shall submit a 1 pound sample of the product four (4) weeks before its use on the Project Site for the Acceptance. The Contractor may salvage existing on site topsoil and/or import topsoil and/or prepare soil using soil preparation. If imported topsoil is used the Contractor shall submit a written notice to CDOT at least 30 days before hauling soil to the site. The Contractor shall supply a sample of the topsoil to Colorado State University Testing Laboratory for analysis. A Certificate of Compliance shall

be submitted to the Engineer and to CDOT to verify the necessary requirements. Topsoil specifications and requirements are listed in the Project Aesthetic Plans.

The area where imported topsoil is excavated and/or stored shall be free of noxious weeds. Topsoil shall contain the following minimum ammonium DPTA (chelate) extractable nutrients (the extracting solution used by CSU Soil Testing Laboratory).

Nitrogen	5 ppm air dried basis
Phosphorus	5 ppm
Potassium	30 ppm
Iron (Fe)	5 ppm

At the Contractor's option soil preparation as described below may be used instead of topsoil.

REVISION OF SECTION 212 - ORGANIC AMENDMENT

Subsection 212.01 shall include the following:

The Work shall consist of incorporation of an organic amendment into the top six inches of the soil to be seeded.

Subsection 212.03 shall include the following:

All seeded areas shall be amended with composted organic amendment as shown on the plans, which shall be tilled or ripped, to a depth of six inches into the soil. After ripping, remove all debris such as concrete, rocks (greater than three inches in diameter), and other deleterious or undesirable material from the area.

17.4 Deliverables

The Contractor shall submit the following to the CDOT for review, Approval, and/or Acceptance:

Deliverable	Review, Acceptance, or Approval	Schedule
Landscape Plan, including Noxious Weed Management Plan and irrigation plan	Review/Acceptance	As Part of The Preliminary Design Plans (30%), Pre-RFC Review Documents, and Final RFC Document Submittals and prior to NTP 2
Landscape walkthrough and installation of temporary fencing for the protection of all existing vegetation that is designated to remain undisturbed,	Acceptance	After tagging all existing plant material according to the Landscape Plan and prior to construction
A 1-pound sample and Certificate of Compliance for imported topsoil and 2-pound sample of organic soil amendments and Certificate of Compliance	Acceptance	Four (4) weeks before its use on the Project Site
Substantial Landscape Completion	Acceptance	Prior to Substantial Landscape Completion, a landscape inspection shall be held with CDOT to determine Acceptance of plant material, seeding areas, and irrigation systems. Upon Acceptance CDOT will issue a "Notice of Substantial Landscape Completion."
Landscape Maintenance Plan	Acceptance	In accordance with the requirements of Section 214 of the Standard Specifications and prior to requesting Project Final Acceptance
Landscape Acceptance	Acceptance	According to requirements of Section 17.2.9.4

18.0 MAINTENANCE DURING CONSTRUCTION

18.1 Maintenance Administration

18.1.1 Responsibilities for Maintenance

The responsibility for performing maintenance of the Highway within the project limits and at the various Project Segments shall be the Contractor's responsibility and shall conform to Sections 104.04, 105.19, 105.20, and 107.17 of the 2011 Standard Specifications for Road and Bridge Construction, and as described herein.

The responsibility for performing maintenance of C-470 and interchange ramps will be shared by CDOT and the Contractor. ADA compliant pathways with an all-weather surface shall be provided and maintained at all times by the Contractor. The requirements herein define those maintenance Work responsibilities that shall be performed by the Contractor and those that will remain the responsibility of CDOT. All Work shall conform to the CDOT *Highway Maintenance Level of Service Manual* and as shown in the Reference Documents.

18.1.1.1 Initiation of Contractor Maintenance Responsibilities

The Contractor will commence maintenance responsibilities beginning upon first mobilization for any work on the Project through Final Acceptance, including any and all project suspensions for weather and/or seasonal shut downs.

18.1.1.2 Termination of Contractor Maintenance Responsibilities

All responsibilities assigned to the Contractor shall remain as defined until Final Acceptance.

18.1.2 Maintenance Level of Service Plan

The Contractor shall develop and submit to CDOT a Maintenance Level of Service Plan. The plan shall define the Contractor's complete strategy for the implementation, coordination, scheduling, and monitoring of maintenance Activities during the Project. For C-470 the Plan shall conform to the CDOT *Highway Maintenance Level of Service Manual* and be updated every six months or as needed to reflect changes in the Contractor's construction Activities. The Maintenance Level of Service Plan shall also address the following components:

1. Maintenance Condition Survey

   Every six months, the Contractor shall perform a detailed survey of maintenance conditions for the Highway and any Road provided for construction phasing until all of the Contractor's maintenance responsibilities are complete (Final Acceptance). The results of the survey shall be documented by the Contractor and submitted to CDOT for Acceptance.

2. Monthly Maintenance Progress Report

   Monthly Maintenance Progress Reports shall be required for the full term of the Contractor's maintenance responsibilities. These reports shall detail all maintenance Activities performed, monitored maintenance condition of existing facilities, identification of any deficiencies from minimum standards, and an action plan for correcting the deficiencies. Monthly Maintenance Progress Reports shall be submitted to CDOT each month with the invoice submittal as required in Book 2, Section 2, Project Management.

The Maintenance Level of Service Plan shall be submitted to CDOT for Approval at least 15 Days prior to NTP2.

18.1.3 Maintenance Responsibilities of the Contractor

Except as specifically assigned to CDOT in Section 18.1.4 below, the Contractor shall perform all required maintenance Activities for all roadways within the project limits, including, but not limited to:

1. Patching and repair of existing pavements and detour pavements
2. Patching and repair of all existing structures included as a part of the Project
3. Repair of shoulder drop-offs
4. Replacement and repair of existing Hot Bituminous Pavement (HBP) shoulders
5. Snow and ice removal for lanes closed to traffic and behind all temporary barrier
6. Snow and ice removal from public trails within the project limits.
7. Maintenance of access along the adjacent C-470 Trail.
8. Compliance to ADA requirements for all-weather surfaces of all pathways and accesses at all times
9. Maintenance of delineators, temporary and permanent signs and pavement markings
10. Drainage maintenance
11. HBP overlays of existing pavements and structures utilized as detours or as a part of the Contractor's Maintenance of Traffic (MOT) plans
12. Replacement of damaged guardrail, bridge rail, barriers, and glare screens
13. Repair of impact attenuators
14. Vegetation control in conformance with local agency ordinances
15. Litter control
16. Graffiti removal (graffiti shall be removed within 24 hours of notification and surface shall be the same color as the original)
17. Activities described in Appendix A, Maintenance Performance Specifications (During Construction)
18. Debris removal responsive to providing the minimum lane requirements in Book 2, Section 16, Maintenance of Traffic

19. Sweeping to CDOT MLOS requirements and once every two weeks and within 72 hours after every storm event.

Snow removal operations in the lanes closed to traffic and behind all temporary barriers shall be done in a way to avoid placing snow back into open lanes to traffic. Snow must be removed far enough from the edge of travel lane that runoff from melting snow will not enter into the travel lanes.

Any items (debris) of value discovered by the Contractor in the highway shall be held by the Contractor no longer than 30 Days in consideration of claim by the original owner. This includes temporary advertisement signs. If the original owner does not claim these items within 30 Days, the Contractor shall then relinquish the items (debris) of value to CDOT's Maintenance Staff for storage and the Contractor may dispose of all advertising material at its discretion.

If repair or removal of items illegally dumped on any ROW or easement is required, the Contractor shall perform such services within 3 Working Days from the date discovered or reported.

18.1.4 Maintenance Responsibilities of CDOT

CDOT will perform the following maintenance Activities:

1. Inspection of structures
2. Patching and repair of all existing structures excluded from the Project.
3. Snow and ice control for all lanes open to traffic on C-470 prior to and during a snow event.

18.1.5 Limits of Maintenance Responsibilities

The longitudinal limits of the Contractor's maintenance responsibilities on the Project shall conform to the limits of the Project, including all portions of the Work.

The lateral limits shall be the ROW mainline, and ramps within the Project Site. Any other areas disturbed by Contractor Activities, outside of these limits, shall be the sole maintenance responsibility of the Contractor.

18.1.6 Excluded Areas

There are no exclusions within the Project limits.

18.1.7 Payment for Maintenance During Construction

Progress payments for maintenance during construction shall be according to Book 2, Section 2, Project Management.

18.2 Performance Specifications

In performance of maintenance on the Project, the Contractor shall comply with the CDOT *Highway Maintenance Level of Service Manual*. Specifically, the Contractor shall adhere to the requirements for data collection and measurement for equating level of service (LOS) on the Highway and incorporate these requirements into its performance of all maintenance Work according to the maintenance of LOS plan.

18.3 Right-of-Way Construction Requirements

18.3.1 Risk of Loss, Obligation to Maintain and Repair

The Contractor shall comply with requirements in Book 2, Section 8, Right of Way, and shall maintain improvements and provide reasonable safety and security measures to preserve any acquired ROW or easements (temporary or permanent). The Contractor shall prevent, minimize, or correct problems such as vandalism, trespassing, rodent infestation, weed control (in accordance with any local agency ordinances), illegal dumping or disposal of rubble, and other debris on all areas of the Project that are under the Contractor's maintenance responsibility.

18.3.1.1 Loss Prevention Methods

Once the Contractor permission to enter has been acquired, in accordance with Book 2, Section 8, Right of Way, the Contractor shall manage and minimize losses to the property by utilizing some or all of the following loss prevention methods:

1. Daily site inspections
2. Installation of chain link security fencing along property boundaries
3. Installation of locking devices, accessible by Project personnel only on buildings, structures, and other improvements located on a parcel
4. Monthly inspection and application of pest/rodent control measures on each parcel
5. Coordination with local law enforcement agencies and neighborhood watch groups to increase awareness about vandalism, illegal dumping, or indication of trespass or other illegal Activity on any parcel
6. Any other means and method determined necessary by CDOT or the Contractor to manage and minimize loss to the property or improvement

18.4 Deliverables

The Contractor shall submit the following to CDOT for review, Approval, and/or Acceptance:

Deliverable	Review, Acceptance or Approval	Schedule
Maintenance Level of Service Plan	Approval	At least 15 Days prior to NTP2, then update every 6 months or as needed
Maintenance condition surveys	Acceptance	Concurrent with the Maintenance Level of Service Plan update
Maintenance progress reports	Review	Concurrent with each Monthly Invoice submittal

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

18.5 Appendices

Appendix A Maintenance Performance Specifications (During Construction)

APPENDIX A

MAINTENANCE PERFORMANCE SPECIFICATIONS (DURING CONSTRUCTION)

The following is an item Activities listing from CDOT's *Highway Levels of Service Manual*, for which the Contractor shall be responsible during construction.

Maintenance Program Area: Roadway Surface (150)

Survey Item	CDOT Activities Number
Patching/Minor Surface Repair	152
Patching-Machine, Overlay and Leveling	154
Blading – Existing Unpaved Surface/Shoulder	162
Building / Restoring Unpaved Surface/Shoulder	163
Base Stabilization and Repair	164

Maintenance Program Area: Roadside Facilities (200)

Survey Item	CDOT Activities Number
Drainage Structures Clean, Repair or Replace	202
Maintenance of Ditches and Streambeds	206
Slope Repair	210
Fence, Gate Cleaning & Maintenance	216
Litter Barrel and Trash Cleanup	218
Sweeping – Machine	220
Sweeping – Hand	222

Maintenance Program Area: Roadside Appearance (250)

Survey Item	CDOT Activities Number
Vegetation Control – Dry Land	252
Vegetation Control – Bluegrass	253
Vegetation Control – Hand Mowing, Weeding	254
Vegetation Control – Herbicide & Pesticide App	256
Vegetation Control – Irrigation	258
Tree Planting, Removal, Trimming	260

Maintenance Program Area: Traffic Services (300)

Survey Item	CDOT Activities Number
Traffic Signs	302, 303
Delineators, Mile Markers	304
Metal Guardrail	306
Concrete Guardrail	307
Pavement Striping, Pavement Markings	308, 310
Roadway, Sign Lighting	312
Traffic Signals	314
Energy Attenuators	316
Electrical Wiring	320
Interconnect Systems	326

Maintenance Program Area: Structure Maintenance (350)

Survey Item	CDOT Activities Number
Bridge Decks	353
Bridge Superstructure	354
Bridge / Structure Painting	355
Bridge Curbs, Railings	356
Bridge Structure Bearings	357
Bridge Substructure	358
Bridge Approaches, Slopes	360
Bridge Deck Expansion Devices	364

Maintenance Program Area: Snow and Ice Control (400)

Survey Item	CDOT Activities Number
Snow Removal (Lanes Closed to Traffic)	402
Ice Control – Drainage Related	403

19.0 INTELLIGENT TRANSPORTATION SYSTEMS (ITS) AND TOLL COLLECTION INFRASTRUCTURE

The Contractor shall provide the Intelligent Transportation System (ITS) and Electronic Toll Collection (ETC) infrastructure elements for the Project. The purpose of these elements is to inform the roadway users, collect various data to assist agencies in the maintenance and operation of the facility, and collect the tolling revenue to support the Project's funding sources.

The ITS system includes various devices, such as Variable Message Signs (VMS), Closed Circuit Television (CCTV) Cameras, Ramp Meter Stations (RMS), Microwave Vehicle Radar Detectors (MVRD), Travel Time Indicators (TTI), Automatic Traffic Recorders (ATR), Doppler Radar, Road Weather Information Systems (RWIS), and Variable Toll Message Signs (VTMS). In addition, the ITS system includes the various components that make up the communication system, such as conduit, fiber optic cable, and Ethernet switches.

The ETC system includes additional items such as Automatic Vehicle Identification (AVI) Readers, Automatic License Plate Recognition (ALPR) Cameras, Loop Detectors, and ETC Lane Controller Cabinets. The ETC system will rely on the fiber optic infrastructure to link the ETC field devices to the ETC back-office.

The Contractor shall be responsible for the design, furnishing, and installation of all ITS devices, the communications network, the supporting infrastructure that is necessary to maintain the existing ITS infrastructure, and the supporting infrastructure that is necessary to install and operate the ETC system components. The actual ETC system components shall be designed and installed by the ETC System Integrator, which will be E-470 Public Highway Authority (E-470). All ITS and ETC elements of the Project shall comply with the requirements of this Section. Additionally, testing and integration shall be performed per the Testing and Integration Plan included as Appendix B to this Section 19.

All design and construction shall comply with the relevant requirements and standards listed in Book 3. Use the most current version of each listed standard as of the final issue date of this RFP, unless modified by Addendum or Change Order. In addition, use the references listed in the Reference Documents as supplementary information.

19.0.1 List of Abbreviations

AC	Alternating Current
ACL	Access Control List
ALPR	Automatic License Plate Recognition
ARE	Additional Requested Element
ATR	Automatic Traffic Recorder
AVI	Automatic Vehicle Identification
CDOT	Colorado Department of Transportation
CCTV	Closed Circuit Television
CTMC	Colorado Transportation Management Center
CTMS	Colorado Transportation Management Software
CWDM	Coarse Wavelength Division Multiplexing
DSRC	Dedicated Short Range Communications

DTD	Division of Transportation Development
ETC	Electronic Toll Collection
HPTE	High-Performance Transportation Enterprise
IGMP	Internet Group Management Protocol
IP	Internet Protocol
ITS	Intelligent Transportation System
LED	Light Emitting Diode
MVRD	Microwave Vehicle Radar Detector
NEC	National Electric Code
NTCIP	National Transportation Communications for ITS Protocol
OCR	Optical Character Recognition
OSHA	Occupational Health and Safety Administration
PA	Public Address
PoE	Power over Ethernet
QoS	Quality of Service
RFC	Released for Construction
RFP	Request for Proposals
RMS	Ramp Meter Station
ROW	Right-of-Way
RWIS	Road Weather Information System
SFP	Small Form-factor Pluggable
SMFO	Single-Mode Fiber Optic
SNMP	Simple Network Management Protocol
TTI	Travel Time Indicator
UPS	Uninterrupted Power Supply
VLAN	Virtual Local Area Network
VMS	Variable Message Sign
VTMS	Variable Toll Message Sign

19.0.2 List of References

Author	Title
CDOT	2011 *Standard Specifications for Road and Bridge Construction*
CDOT	*M & S Standards* – June 27, 2011
CDOT	CDOT *Sign Design Manual* – May 21, 2010
RTD	Design Guidelines and Criteria
AASHTO	*A Policy on Geometric Design of Highways and Streets*
AASHTO	*Roadside Design Guide*
ASTM	American Society for Testing and Materials
EIA	Electronic Industries Alliance
FHWA	*Manual on Uniform Traffic Control Devices* (Current Edition)
ICEA	Insulated Cable Engineers Association
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITU	International Telecommunications Union
NFPA	*National Electric Code* (Current Edition)
RUS	Rural Utilities Service
Telcordia	Telcordia Technologies
TIA	Telecommunications Industry Association

19.1 Design Requirements

The Contractor shall design the ITS and ETC infrastructure components in accordance with the requirements in the following Sections. No part or attachment of any equipment shall be substituted or applied contrary to the manufacturer's recommendations and standard practices. Infrastructure locations need to meet the requirements of CDOT and the ETC System Integrator.

The Contractor shall submit both preliminary design level and RFC level ITS/ETC Design Plans for Acceptance by CDOT. These ITS/ETC Design Plans will be reviewed by both CDOT and the ETC System Integrator. The ITS/ETC Design Plans shall show all known utility information.

The Contractor shall submit a Temporary Communications & Device Plan to CDOT for Approval prior to RFC. This plan shall describe how the Contractor plans to maintain and keep operational all existing ITS devices during construction.

Refer to Appendix 19-A Project Special Provisions for design requirements in addition to those described in the following Sections.

19.1.1 Electrical Power

The Contractor shall provide alternating current (AC) power service to every ITS and ETC device and cabinet that does not have existing metered service. This includes all existing devices or cabinets that are relocated by the Contractor. The Contractor shall obtain (from the power service provider) approval of the power service design and coordinate and meet all requirements as specified by the power service provider for the complete and operational power service to all

required locations. The lighting, ITS, and ETC equipment shall each be on separate circuits. The ITS and ETC equipment can be on the same meter, with the lighting on a separate meter (for billing purposes). All power connections to devices shall include a quick-disconnect. Separate disconnects shall be installed for ITS and ETC devices.

The Contractor shall be responsible for the coordination of power source work to be performed by Xcel Energy. The Contractor shall contact the Xcel Energy Builder's Call Line at 1-800-628-2121 to request, and process to completion, the required coordination to establish the metered power sources for ITS and ETC devices. The Contractor shall perform all work necessary to maintain existing or establish new metered power sources for ITS and ETC devices. All cost charges from the power service provider, and all necessary materials, including meter, labor, and coordination required to maintain existing or establish new metered power sources shall be included in the Work.

19.1.2 Location and Protection of ITS and ETC Elements

The Contractor shall locate all ITS and ETC infrastructure elements within the public Right-of-Way (ROW) such that routine maintenance, including the use of a bucket truck, will only require minimal impact to traffic operations. Whenever possible, ITS and ETC elements shall not be located in the highway median, except the center support of freeway VTMS and TTI related to the express lane, ETC lane controller cabinets, and AVI and ALPR support structures.

All existing underground utilities shall be identified, and all ITS and ETC infrastructure elements shall be designed to avoid or minimize conflicts with these facilities. The Contractor shall be responsible for all repairs to facilities damaged during construction. The Contractor shall be responsible for maintaining and keeping operational all existing ITS devices during construction.

All existing lateral cables to remain that are currently spliced into the backbone shall be identified by the Contractor and re-spliced to the new backbone cable. The Contractor shall audit and verify all existing splice closures and available fibers prior to this work.

The Contractor shall ensure that all equipment, including but not limited to, devices, interconnect wiring, communications devices, communications lines, power supplies, antennas, operator controls, and power service are protected to eliminate damage by external and internal sources (including power surges), lightning, induced voltages, and static discharge. A grounding system and protection devices that are suitable for the specific installation and equipment shall be designed.

ITS/ETC Design Plans shall show existing and proposed underground and overhead utilities and drainage facilities to aid in determining conflicts during design reviews.

19.1.3 Communication System

The communications system is used to transmit data and video to and from all existing and proposed ITS devices. In addition, the system is responsible for transmitting all ETC tolling data to and from the back-office for processing, issuing of tolls, and updating of information in the lanes.

19.1.3.1 Design Requirements

The Contractor shall design a fiber optic communication system to replace the existing fiber optic communication. The system shall be capable of transporting data and video signals between field devices. Communications backbone shall be located within the Right-of-Way (ROW) line and be designed to accommodate CDOT's ultimate configuration for C-470. Additionally, the communications backbone shall not be located in the travelled way, shoulder, or bikeway, with exception of crossings. The communications backbone shall not cross the traveled way, shoulder, or bikeway more than two times within the limits of the Project.

The Contractor shall coordinate all ITS Device relocations with CDOT ITS. The Contractor shall be responsible for all costs associated with any impacts or relocation to the fiber optic lines caused by their design or construction. Contractor shall provide Internet Protocol (IP) Ethernet communication to all ITS devices within the Project limits with the exception of ramp meters; optical transceivers shall be used for ramp meter communications. However, the MVRD units at RMS locations shall be connected to both the CDOT ITS network utilizing IP Ethernet communication and the ramp meter network utilizing optical transceivers. The Ethernet Switches for these MVRD units at RMS shall be installed in the ground mounted RMS cabinets.

All fiber allocations, splicing diagrams, and network diagrams shall be prepared by the Contractor and submitted to CDOT for Approval. On the west end of the Project limits, the Contractor shall install the proposed fiber optic backbone cable to approximately Wadsworth Boulevard at an appropriate existing cable end splice location as approved by CDOT. On the east end of the Project limits, the Contractor shall terminate the new fiber optic backbone cable at the County Line Node Building. Splicing of fiber optic cable shall be performed in manholes only.

All splices for ITS device laterals to the fiber optic backbone shall utilize Coarse Wavelength Division Multiplexing (CWDM) splicing, with the exception of ramp meter laterals. Ramp meter lateral splices to the backbone shall utilize standard optics. Toll point lateral splices to the backbone shall also utilize standard optics. Standard optics shall be defined as that operating within the O-band transmission window (notably 1310 nm).

Lateral splices to the fiber optic backbone shall be spaced no closer than ½ mile apart, unless otherwise Approved by CDOT ITS. End-to-end fiber optic backbone splices shall be spaced no closer than 20,000 feet apart; exact locations shall be Approved by CDOT ITS.

The existing C-470 fiber optic backbone has two fibers allocated to Douglas County, and two fibers allocated as Future Douglas County, all of which are in the Aqua buffer tube. In addition to re-splicing all existing connections from the 48-strand fiber optic cable running north/south along Santa Fe Drive, the Contractor shall make the connection for all four of these fibers allocated to Douglas County.

One fiber buffer tube (12 fiber strands) will be allocated to E-470 along the C-470 backbone from the County Line Node west to the CTMC. The Contractor shall be responsible for all splicing work necessary to provide this communications path. Additionally, the Contractor shall be responsible for all splicing work necessary to provide a redundant communications path from the County Line Node to E-470's back-office location and redundant communications paths for each toll point location. A redundant communications path means that each of the Brocade Ethernet Switches for the toll points shall be daisy chained, as opposed to providing a dedicated pair of fibers for each toll point. This redundant path shall use CDOT's fiber north from the County Line Node along I-25, east on Arapahoe Road, south on Parker Road, and then east along E-470's fiber to

their back-office location. Up to four fibers are being allocated to C-470 on the existing fiber cable that runs north on I-25 from the County Line Node Building. The fiber cable running north from the County Line Node Building is a 96 strand cable. The Contractor should assume that the allocated fibers in the existing fiber cable are not yet terminated in the County Line Node Building.

The Contractor should assume there is one location where a buffer tube needs to be spliced between Wadsworth and the CTMC.

The Contractor shall submit Network Diagrams to CDOT for Approval prior to RFC. These Network Diagrams will be reviewed by both CDOT and the ETC System Integrator.

19.1.3.2 Material Requirements

The Contractor shall furnish all components required to achieve a fully-functioning communications system, excluding tolling equipment to be installed in ETC lane controller cabinets. The communications system shall be designed based on the following material requirements, at a minimum:

- Provide a 144 strand SMFO cable for the communications backbone.
- Provide 12-strand SMFO cable laterals from the CDOT backbone to all DTD, ITS, and ETC field devices, except Doppler Radar units.
- Provide fiber quick disconnects at all unprotected ITS device and equipment locations where new laterals are installed. The fiber quick disconnects shall allow the fiber laterals to be disconnected to prevent damage to the fiber backbone in case any of the devices or equipment along the corridor are damaged. The fiber quick disconnect shall be installed in areas where they will not be submerged in water and per the manufacturer's recommendations. Bend insensitive (ITU-T G.657 A) tactical fiber optic cable with a polyurethane jacket shall be used for all patch cables and shall be fully compatible with all fiber optic laterals.
- Provide hardened Ethernet switches with 8 10/100 Ethernet ports in addition to two Small Form-Factor Pluggable (SFP) based 1 Gigabit Ethernet ports. Each switch shall provide Virtual LAN (VLAN) Quality of Service (QoS), Internet Group Management Protocol v3 (IGMP) snooping/filtering, and security access control lists (ACLs) and SNMPv1, SNMPv2, and SNMPv3 management protocols. The switches shall also provide sufficiently sized optics for each device. Optical attenuators shall also be provided. Per Appendix 19-A Project Special Provisions, Ciena 3930 or 3931 are required at ITS device locations throughout the Project corridor and a Ciena 5160 is required at the County Line Node Building.
- Provide fiber optic termination panels at ITS field devices and the County Line Node Building per Appendix 19-A Project Special Provisions.

19.1.4 Variable Message Signs

The VMS are large dynamic displays that are used for a wide range of purposes, including providing driver information regarding weather advisories, travel times, amber alerts, and construction and incident notifications. The VMS along C-470 will not be used for tolling purposes.

There are three existing shoulder mounted VMS within the Project limits at the following approximate locations:

- Eastbound at Platte Canyon (Mile Point 15.53, Project Station 852+79),
- Eastbound at Holly Street (Mile Point 23.19, Project Station 1258+83), and
- Westbound approximately 3,000 feet east of Quebec Street (Mile Point 24.76, Project Station 1342+34).

19.1.4.1 Design Requirements

The Contractor shall replace the existing eastbound VMS at Holly Street with a new VMS on a cantilever structure at a nearby shoulder mounted location as approved by CDOT. All other existing shoulder mounted VMS within the Project limits shall be relocated to another suitable shoulder mounted location as approved by CDOT, if they are impacted by the Project. Where ROW permits, an 8-foot-wide paved area shall be provided, outside of the shoulder, for maintenance access. If relocation of an existing VMS Cabinet is proposed, the Contractor shall provide inspection and a design report for certification that the existing cabinet and its structural elements, including the support angle connection members which will attach to new sign structures, are adequate for reuse and can accommodate the required loading and configuration of attachment to the new sign structure, as detailed in S-614-60. The design report for certification shall be signed and sealed by the Contractor's Engineer, and submitted to CDOT for Acceptance. All new mounting hardware is required for reuse of existing VMS cabinets. If any structural modifications to the cabinet are proposed, including the angle connection members, shop drawings and calculations shall be submitted to CDOT for Acceptance. The shop drawings and calculations shall be signed and sealed by the Contractor Engineer.

The new VMS design shall include a UPS.

The Contractor shall prepare a structural design including cross sections for each VMS structure and provide to CDOT for Approval prior to RFC. The Contractor may not reuse existing VMS sign structures for permanent VMS installations.

VMS shall have a minimum of 18 feet of vertical clearance above the highest point of the roadway and meet the current MUTCD standards.

All existing VMS removed by the Contractor that are not reset shall be returned to CDOT.

19.1.4.2 Material Requirements

The Contractor shall furnish any new VMS signs and any and all associated equipment necessary to achieve a fully-functioning system. The new VMS signs shall be designed based on the following material requirements, at a minimum:

1. The sign shall utilize Light Emitting Diode (LED) displays.
2. The sign shall be equipped with the ability to display three lines of text with a character height of 18 inches.
3. The sign shall utilize a full-matrix display.
4. The sign must have a walk-in cabinet.
5. The sign shall have a minimum design life of 20 years.

6. The VMS controller and sign must be NTCIP compliant, provide an Ethernet interface, and must be compatible with the Colorado Transportation Management Software (CTMS).

19.1.5 Closed Circuit Television (CCTV)

The CCTV cameras are used for monitoring travel conditions in the corridor, such as weather conditions, accidents, traffic congestion, and other events. The video images are also shared with the public via the internet (www.CoTrip.org) and television news agencies.

19.1.5.1 Design Requirements

The Contractor shall design a CCTV system that provides full surveillance coverage along the extent of the new CDOT fiber optic backbone with no obstructions. The coverage shall include the entire roadway surface, including all mainline lanes, ramp lanes, and interchanges at a minimum of 32x optical zoom and 12x digital zoom. Cameras shall be spaced no more than one mile apart. The Contractor shall prepare a coverage plan to be submitted to CDOT for Approval during preliminary design to demonstrate proper CCTV coverage.

The existing CCTV camera located at approximately Mile Point 14.99 (Project Station 824+50) may be reset within 500 feet of its existing location. The Contractor's design shall include new CCTV cameras within 500 feet of each existing CCTV camera that is being replaced within the Project limits. Additional CCTV cameras shall be installed at the following approximate locations:

1. Mile Point 16.33 (Project Station 895+00), and
2. Mile Point 21.65 (Project Station 1177+50).

Revisions to these locations may be made if approved by CDOT. Furthermore, if any areas are shown to not have coverage based on the Contractor's coverage plan, additional cameras shall be required in order to provide full coverage of the Project corridor.

Each new CCTV camera pole shall be steel and have a lowering device to lower the camera for maintenance purposes. All new CCTV camera poles shall be placed as far away from the roadway as practically possible within the right-of-way, while still providing full surveillance coverage. If any new CCTV camera poles are placed within the clear zone they shall be protected in accordance with the *Roadside Design Guide* (AASHTO). The Contractor shall provide a full design for the installation of the pole and appropriate foundation within the ITS/ETC Design Plans. Additionally, the Contractor shall submit cross section drawings for each of the proposed CCTV locations to CDOT for Approval prior to RFC.

19.1.5.2 Material Requirements

The Contractor shall furnish any new CCTV cameras and any and all associated equipment necessary to achieve a fully-functioning system. All CCTV cameras within the Project limits shall meet the following minimum requirements:

1. High Definition and Ethernet-based,
2. All-in-one color surveillance dome camera unit (IP66 and NEMA 4x ratings),
3. Pan, 220 degree tilt, zoom operation,
4. Minimum 32x optical zoom and 12x digital zoom,
5. Minimum illumination no less than 0.3 lux, and
6. H.264 video stream.

The CCTV camera shall also include a weatherproof dome housing, steel pole, lowering device, mount adapter, camera transformer, attachment hardware and all other hardware, cables, and test equipment necessary for a complete installation. New poles shall be a minimum of 50 feet in height and include the proper foundation. Higher poles may be required to meet coverage requirements. The poles shall also include a lowering device that allows CCTV cameras to be lowered to the ground for maintenance purposes without interfering with any other pole-mounted devices or cabinets.

Existing CCTV cameras located outside of the Project limits may be utilized at their existing locations. However, resets of existing cameras are not allowed unless they meet the minimum requirements outlined above. All existing CCTV cameras not utilized by the Contractor shall be salvaged and returned to CDOT ITS.

19.1.6 Ramp Meter Stations (RMS)

The RMS help control the number of vehicles entering C-470 when the highway experiences congestion. There are currently 11 RMS operating within the Project limits, including:

1. Westbound on-ramp at the Yosemite Street interchange,
2. Westbound on-ramp at the Quebec Street interchange,
3. Eastbound on-ramp at the University Boulevard interchange,
4. Westbound on-ramp at the University Boulevard interchange,
5. Eastbound on-ramp at the Broadway interchange,
6. Westbound on-ramp at the Broadway interchange,
7. Eastbound on-ramp at the Lucent Boulevard interchange,
8. Westbound on-ramp at the Lucent Boulevard interchange,
9. Eastbound on-ramp at the Santa Fe Drive interchange,
10. Westbound on-ramp at the Santa Fe Drive interchange, and
11. Eastbound on-ramp at the Wadsworth Boulevard interchange.

19.1.6.1 Design Requirements

The Contractor shall replace all existing RMS detection with Microwave Vehicle Radar Detectors (MVRD) (also see 19.1.7 Microwave Vehicle Radar Detectors (MVRD)) for mainline detection and detector loops for on-ramp detection. If the Contractor impacts any of the existing RMS along the corridor, the Contractor shall design and reconstruct a fully functioning RMS in accordance with the latest CDOT guidelines on ramp metering stations.

In addition, the Contractor shall design and construct new RMS at the following location:

1. Eastbound on-ramp at the Quebec interchange with a two-lane RMS. There is an existing ATR at this location that previously was a RMS; the Contractor shall convert this existing ATR back to an RMS.

19.1.6.2 Material Requirements

The Contractor shall furnish all the elements of the RMS necessary to achieve a fully-functioning system. All RMS shall utilize the following components:

1. MVRD to collect mainline data for each lane and associated loop emulation cards,
2. Detector loops for on-ramp detection and associated loop amplifier cards,
3. Where impacted, install new or reset existing 334 controller cabinets and controllers on new fiberglass porch-style foundations, and
4. Pull boxes, conduit, communications, controllers, signal equipment, advance flashers, wiring, and all other items necessary to provide a complete and functioning RMS.

Existing RMS cabinets, controllers, and communications equipment may be salvaged and reused. Existing ATR cabinet and controller at the eastbound on-ramp at the Quebec interchange may be salvaged and reused as part of the RMS at this location.

19.1.7 Microwave Vehicle Radar Detectors (MVRD)

MVRD, also referred to as side-fire radar, are used to collect point data of volume, occupancy, speed, and classification in each lane of travel. The data is used primarily for measuring and analysis of traffic conditions, both real-time and for studies.

19.1.7.1 Design Requirements

The Contractor shall prepare a design to locate MVRD units within 500 feet of each existing MVRD location within the Project limits. This requirement may be met with either existing MVRD units remaining in place or reset MVRD units as long as they meet the minimum requirements stated herein. Additional new MVRD units shall be installed at the following approximate locations:

1. Mile Point 14.99 (Project Station 824+48),
2. Mile Point 16.33 (Project Station 895+00),
3. Mile Point 21.65 (Project Station 1177+50),
4. Mile Point 22.60 (Project Station 1227+49),
5. Mile Point 23.19 (Project Station 1258+83), and
6. Mile Point 24.76 (Project Station 1342+34).

These locations are in addition to the MVRD units required at RMS. Revisions to these locations may be made if approved by CDOT.

19.1.7.2 Material Requirements

The Contractor shall furnish any new MVRD units and any and all associated equipment necessary to achieve a fully-functioning system. All MVRD units within the Project limits shall be a Wavetronix SmartSensor HD. All MVRD units within the Project limits shall detect all individual lanes of travel, including the general purpose and express lane(s) in both directions. Data collection shall include volume, occupancy, speed, and classification.

If colocation on a CCTV pole or sign structure is not feasible for reset or new MVRD units, a new ITS Pole of an appropriate height to allow for detection of all individual lanes of travel shall be used.

19.1.8 Travel Time Indicators (TTI)

TTI sites are comprised of antennas and readers that detect toll tag transponders in vehicles. While MVRD units give volume, occupancy, and speed data at a given point, the TTI are used to track vehicle travel times across segments spanning from one TTI location to the next.

19.1.8.1 Design Requirements

The existing TTI units within the Project limits shall be relocated to another suitable location, as approved by CDOT, if they are impacted by the Project or if their existing location is within the median. The relocated TTI units shall be installed with similar spacing as the existing TTI units, or as Approved by CDOT ITS, and along the outside shoulder. All existing and/or relocated TTI units shall be adjusted per manufacturer's recommendations to obtain directional travel times of only vehicles within the general purpose lanes.

For the express lanes, one set of TTI units shall be located between each ingress/egress point and successive egress points to capture vehicles in all possible segments. These TTI units shall be installed per manufacturer's recommendations to obtain directional travel times of only vehicles within the express lanes for each segment.

TTI units shall be located at least 1,000 feet from toll points.

The TTI units cannot be placed in the median except for those intended to collect data for the express lanes.

19.1.8.2 Material Requirements

For the express lane installations, the Contractor shall furnish all new TTI units and any and all associated equipment necessary to achieve a fully-functioning system. The TTI units must be Sirit 6204 multi-protocol readers and antennae and be able to read both Title 21 and ISO 18000-6C transponder tags.

For the general purpose lane installation, the Contractor shall reset existing TTI units and furnish any and all associated equipment necessary to achieve a fully-functioning system.

19.1.9 DTD Automatic Traffic Recorders (DTD ATR)

The CDOT Division of Transportation Development (DTD) Automatic Traffic Recorder (ATR) stations continuously collect vehicle volume and functional classification data using in-pavement loops and piezoelectric sensors. Currently, there are two DTD ATR stations at the following locations within the Project limits:

1. Mile Point 16.0 (west of SH 85 / Santa Fe Drive), and
2. Mile Point 25.1 (east of Quebec Street).

19.1.9.1 Design Requirements

The Contractor shall design replacement DTD ATR stations for those locations that are impacted by the Project. Each DTD ATR must collect data for all lanes of travel, including the general purpose lanes and express lanes in both directions.

At the location west of SH 85 / Santa Fe Drive, the existing DTD ATR cabinet shall remain in place and the existing in-pavement loops and piezoelectric sensors shall be replaced at the same mile point as where the existing equipment is located.

At the location east of Quebec Street, the existing DTD ATR utilizes radar units to collect traffic data. This location shall be replaced with a new DTD ATR utilizing in-pavement loops and piezoelectric sensors at the same mile point as where the existing radar detection is located. The existing cabinet at this location shall be disposed of by the Contractor and the new cabinet at this location shall be located north of the roadway, outside of the westbound shoulder. The existing counter shall be relocated to the new cabinet location.

Communications to the DTD ATR stations shall be provided via the existing telephone line. In addition, a 12-strand SMFO lateral for future use shall be provided from the CDOT fiber optic backbone to the DTD ATR cabinet.

19.1.9.2 Material Requirements

The Contractor shall furnish all equipment necessary to achieve a fully-functioning DTD ATR system. The DTD ATR stations consist of loop detector wires and piezoelectric axle sensors.

19.1.10 Region 1 Automatic Traffic Recorders (ATR)

The Region 1 ATR stations are counting stations that continuously collect vehicle volume, speed and occupancy data. Region 1 ATR stations utilize the same equipment as the RMS with the exception of the traffic signal poles and heads. Currently, there is one Region 1 ATR station within the Project limits at the following location:

1. Eastbound on-ramp at the Quebec interchange.

The Contractor shall convert the existing Region 1 ATR (which used to be an RMS) at the eastbound on-ramp at the Quebec interchange to an RMS. See 19.1.6 Ramp Meter Stations (RMS) for more information.

19.1.11 Doppler Radar

These are self-contained, solar-powered units that collect point travel data and transmit it wirelessly to the device manufacturer SpeedInfo and to CDOT. These devices are owned by SpeedInfo.

19.1.11.1 Design Requirements

The SpeedInfo Doppler radar units are self-contained (including wireless communications). All existing units that need to be relocated shall be installed per the manufacturer's recommendations. All Doppler radar units shall be co-located with other sign structures and therefore shall not require separate structures to be installed by the Contractor. The final Doppler radar location shall be such that it picks up the general purpose lanes, not the express lane.

19.1.11.2 Material Requirements

The existing self-contained SpeedInfo DVSS-100 Doppler radar units shall be reset in the same vicinity as the current devices. No additional units shall be provided as part of the Project.

19.1.12 Road Weather Information System (RWIS)

Road Weather Information Systems (RWIS) are used for traveler information systems and highway maintenance operations by providing on-site weather information. There are currently two RWIS operating within the Project limits at the following locations:

1. Northwest quadrant of the I-25 and C-470 interchange, and
2. Northeast quadrant of the Wadsworth Blvd and C-470 interchange.

19.1.12.1 Design Requirements

The Contractor shall upgrade existing RWIS within the Project limits to meet the minimum requirements described herein.

19.1.12.2 Material Requirements

The Contractor shall furnish all new RWIS equipment and any and all associated equipment necessary to achieve a fully-functioning system. All RWIS within the Project limits shall have a weather monitoring system including the following minimum requirements:

1. Remote Processing Unit,
2. Precipitation Type Sensor,
3. Air Temperature/Relative Humidity Sensor,
4. Ultrasonic Wind Sensor,
5. Wireless Road Surface Sensor,
6. Non-Intrusive Pavement Condition Sensor,
7. CCTV camera,
8. Concrete Pad, and
9. Cabinet.

19.1.13 Variable Toll Message Signs (VTMS)

A Variable Toll Message Sign (VTMS) is a combination of a static sign with one or two electronic VMS inserts that are utilized to display the specific tolls for each segment of the corridor. All mainline VTMS shall be located upstream of the express lane ingress/egress points. This will allow the roadway users sufficient time to read the toll rate and then make their decision whether to enter, or continue to use, the express lane(s).

19.1.13.1 Design Requirements

The Contractor shall design a complete VTMS system so that the following requirements are met:

1. VTMS shall be provided prior to each express lane ingress/egress point on the mainline, and the VTMS shall be mounted overhead and visible to both express lane and general purpose lane users, including roadway users that have just entered the facility via on-ramps.
2. VTMS shall be provided on southbound I-25, north of the exit ramp to C-470, and on the exit ramp from northbound I-25 to C-470, prior to each express lane ingress.

3. Each VTMS in the westbound direction shall have two VMS inserts capable of displaying the toll rates to the next two interchange destinations with the exception of where there is only one remaining destination. When there is one destination remaining, the VTMS shall have one VMS insert capable of displaying the toll rate to the final destination.
4. Each VTMS in the eastbound direction shall have one VMS insert capable of displaying the toll rate to the final destination.
5. All VTMS shall be mounted overhead.
6. VTMS structures and structure foundations shall be designed to accommodate future larger signs that will be part of the Ultimate Configuration.

19.1.13.2 Material Requirements

The Contractor shall furnish all new VTMS signs and any and all associated equipment necessary to achieve a fully-functioning system. The VTMS signs shall be designed based on the following material requirements, at a minimum:

1. The sign shall utilize Light Emitting Diode (LED) displays,
2. The signs shall be equipped with the ability to display a minimum of 7 characters, including the toll rate (the $ sign, the numerical value of toll rate, and decimal) or the word “CLOSED”; all with a character height of at least 18 inches,
3. The VTMS shall have a minimum design life of 20 years,
4. The VTMS cabinet shall be installed on a concrete foundation to the right of the travelled way and shoulder so that maintenance can be performed without the need for lane closures,
5. The VTMS controller and sign must be NTCIP-compliant, provide an Ethernet interface, and must be compatible with the CDOT software, and
6. UPS shall be provided for each VTMS to ensure that each sign is operational for 8 hours in the event of a power failure.

The Contractor shall purchase and install the UPS in the VTMS controller cabinet.

19.1.14 Toll Point

The Toll Points collect information from vehicles so that the users are appropriately charged for use of the express lanes. A toll point is defined as a single toll collection point for one direction of travel.

19.1.14.1 Design Requirements

Each toll point includes AVI readers/antennas, ALPR cameras, an ETC lane controller, and a UPS, as well as all associated pull boxes, conduit, cabinets, communications equipment, and power for one direction of travel. The Contractor shall be responsible for the design and installation of the ETC cabinet and associated foundation; the conduit to connect the ETC lane controller to the AVI antenna, in-pavement loops, and ALPR cameras; and providing communications and power to the cabinet.

The Contractor shall install toll points within 1,000 feet of the following locations:

1. Eastbound C-470 at Mile Point 23.65 (Project Station 1283+14),
2. Eastbound C-470 at Mile Point 21.69 (Project Station 1179+17),
3. Eastbound C-470 at Mile Point 17.89 (Project Station 976+62),
4. Westbound C-470 at Mile Point 23.65 (Project Station 1283+14),
5. Westbound C-470 at Mile Point 21.69 (Project Station 1179+17),
6. Westbound C-470 at Mile Point 18.88 (Project Station 1030+10), and
7. Westbound C-470 at Mile Point 17.89 (Project Station 976+62).

Revisions to these locations may be made if approved by CDOT and the ETC System Integrator. The Contractor shall consider environmental factors and utilities in determining exact toll point locations. If ARE #1 is pursued, the eastbound toll point at Mile Point 17.89 (Project Station 976+62) shall be replaced with an eastbound toll point at Mile Point 15.59 (Project Station 855+00).

The Contractor shall submit a single-lane toll point detail and a dual-lane toll point detail for Approval by CDOT prior to RFC. These details will be reviewed by both CDOT and the ETC System Integrator.

UPS shall be provided for each toll point to ensure that each ETC lane controller is operational for 8 hours in the event of a power failure. The Contractor shall purchase and install the UPS in a separate controller cabinet, as described in Appendix 19-A Project Special Provisions.

All pavement joints within the vicinity of a toll point shall be coordinated with E-470.

The Contractor is responsible for providing outlets and circuit(s) in the County Line Node Building to accommodate the ETC System Integrator's servers and network equipment. These new circuit(s) shall be protected by the UPS and generator.

19.1.15 Automatic Vehicle Identification (AVI) Reader

An AVI reader and antennas shall be installed at each tolling point and used to read the tag information stored inside each transponder.

19.1.15.1 Design Requirements

The AVI reader shall be installed by the ETC System Integrator in the ETC lane controller cabinet, and the antennas that will read the tag information shall be mounted directly above the express lane(s). The Contractor shall be responsible for providing a structure at each tolling point (either dedicated or shared with another installation) to allow the ETC System Integrator to mount the AVI antennas in the correct positions. The Contractor shall be responsible for providing a structural design including cross sections for each of these structures at the toll points for CDOT and ETC System Integrator Approval prior to RFC.

The AVI reader that is anticipated to be utilized by the ETC System Integrator is the Sirit Model 6204. Each tolling point will require a structure upon which two antennas (approximately 4 feet wide each), per direction, per express lane, can be mounted 18.5 feet above each express lane. The AVI antenna shall be mounted on a 2-inch diameter pole spanning the express lane(s), allowing a minimum of 6-inches of clearance between the pole and the bottom of the structure for angling and installation of the supporting hardware. The Contractor shall coordinate with the ETC System Integrator to ensure that the proper civil infrastructure and structural attachments are

provided at each AVI antenna installation location. All other antennae or readers shall be mounted a minimum of 1,000 feet away from each AVI reader.

In addition to the structure and mounting brackets, the Contractor shall also provide two 2-inch conduits between the ETC lane controller cabinet and the base of the overhead structure supporting the AVI antenna. All cabling shall be installed internal to the structure, and the contractor shall provide 1 ½" liquid-tight flexible metal conduit from the penetration in the overhead sign structure to the bottom of the bracket where the AVI antenna is mounted. Communications to the AVI antenna shall be provided by coaxial cable installed by the ETC System Integrator. The Contractor shall ensure that the ETC cabinet and the structures used to support the AVI antenna equipment be close together to ensure that the maximum coaxial cable length does not exceed 100 feet.

19.1.15.2 Material Requirements

The Contractor shall be responsible for providing a bracket upon which the ETC System Integrator can mount the AVI antenna. The exact type of bracket will depend on the type of structure that the AVI antenna shall be mounted on. The Contractor shall coordinate with the ETC System Integrator and CDOT to determine the type, number, sizing, and placement of brackets that shall be necessary.

19.1.16 Automatic License Plate Recognition (ALPR) Cameras

The ALPR cameras shall be used to obtain an image of the vehicle's license plate if a transponder is not detected. In-pavement loops shall be used to signal to the ALPR camera that a vehicle is present. Once the image is taken, the Optical Character Recognition (OCR) system inside the camera unit (or the ETC lane controller) will process the image to identify the vehicle's license plate. This information will then be sent to the ETC lane controller. Tolling points require both front-shot and rear-shot cameras, necessitating separate mounting locations.

19.1.16.1 Design Requirements

For the single-lane toll point locations, the ALPR cameras shall be mounted by the ETC System Integrator on break-away sign supports on the concrete median barrier. The Contractor shall be responsible for installing these supports at the locations determined by the ETC System Integrator. It is anticipated that two ALPR supports will be needed at each tolling point. The Contractor shall also provide two 1-inch conduits between the ETC lane controller cabinet and the base of the ALPR camera supports, temporarily capped at the top of the concrete barrier.

For the managed lane adjacent to the median at any dual lane toll point locations, the ALPR cameras shall be mounted by the ETC System Integrator on break-away sign supports on the concrete median barrier. The Contractor shall be responsible for installing these supports at the locations determined by the ETC System Integrator. It is anticipated that two ALPR supports will be needed for this lane, and the Contractor shall also provide two 1-inch conduits between the ETC lane controller cabinet and the base of the ALPR camera supports, temporarily capped at the top of the concrete barrier.

For the managed lane adjacent to the general purpose lanes at any dual lane toll point locations, the ALPR cameras shall be mounted by the ETC System Integrator on overhead bridge structures spanning from the median to the outside shoulder. The Contractor shall be responsible for

installing these structures at the locations determined by the ETC System Integrator. The Contractor shall be responsible for providing a structural design including cross sections for each of these structures at the toll points to CDOT for Approval prior to RFC. In addition to the overhead structures and mounting brackets, the Contractor shall also provide two 2-inch conduits between the ETC lane controller cabinet and the base of the overhead structures supporting the ALPR cameras at these locations.

Communications cabling to the ALPR cameras shall be provided and installed by the ETC System Integrator.

In-pavement loops shall be saw cut into each express lane by the ETC System Integrator. The Contractor shall provide the necessary conduit for the loop installation. The location and quantity of the conduit to be installed by the Contractor shall be coordinated with the ETC System Integrator. The pavement surface temperature must be dry and at least 50 degrees (and not falling) in order for the ETC System Integrator to properly install the in-pavement loop sealant. As a result, the Contractor shall coordinate with the ETC System Integrator to ensure the correct seasonal climate for the in-pavement loop installation.

19.1.16.2 Material Requirements

The Contractor shall design the support system for the ALPR cameras mounted in the concrete median barrier to meet the following material requirements:

1. The break-away sign supports used to mount the ALPR cameras shall be CDOT Standard S-614-21 slipbase barrier stub mounted on the concrete median barrier.
2. Each support shall include mounting brackets and hardware to allow for the installation of the ALPR cameras and a cap for the top of the post.

The Contractor shall design the support system for the ALPR cameras mounted on overhead bridge structures to meet the following material requirements:

1. The bridge structures used to mount the ALPR cameras shall span from the median to the outside shoulder.
2. Each structure shall include mounting brackets and hardware to allow for the installation of the ALPR cameras.

19.1.17 ETC Lane Controller

The ETC lane controller shall be located in a cabinet in the median and shall be connected to the rest of the electronic tolling equipment via conduit system. The ETC lane controller will be used for all data processing and transmittal of transponder tag and license plate information via the fiber optic communications network to the ETC back-office for processing.

19.1.17.1 Design Requirements

Although the ETC System Integrator shall be responsible for the installation and configuration of the ETC lane controller, the Contractor shall be responsible for the design of the ETC lane controller cabinet and associated foundation; the conduit to connect the ETC lane controller to the AVI antenna, and ALPR cameras; and the conduit to provide communications and power to the cabinet. When two single lane toll points are collocated along the corridor, only one ETC lane

controller cabinet will be required for both toll points. When a single lane toll point is collocated with a dual lane toll point, two ETC lane controller cabinets will be required (one for the dual lane toll point and one for the single lane toll point). The locations of the cabinets, foundations, and conduits shall be coordinated with and approved by the ETC System Integrator; however, the maximum conduit length between the ETC lane controller and the ETC devices (AVI antennas and ALPR cameras) shall not exceed 100 feet.

19.1.17.2 Material Requirements

The Contractor shall have the following responsibilities at each tolling point where an ETC lane controller is required:

1. Furnish and install a NEMA Type 3R rated Type M Stretch cabinet with a minimum size of 68 inches high x 31 inches wide x 19 inches deep. Cabinets shall have a backplane with dimensions of 25 inches (width) by 54 inches (height), mounted on fixed bolts.
2. Provide a 12-strand SMFO fiber optic communications lateral between the cabinet and the CDOT fiber optic backbone. The fiber optic lateral shall terminate at a patch panel that shall be installed inside the communications cabinet and be labeled before ETC installation.
3. Provide power to the cabinet to power the ETC lane controller and all associated equipment.
4. Contractor shall deliver tolling cabinet backplane, DIN rail, and circuit breakers to ETC System Integrator.

19.1.18 Pull Boxes and Manholes

19.1.18.1 Design Requirements

The Contractor's design shall utilize fiberglass reinforced, polymer concrete pull boxes and pre-cast concrete manholes as described in Appendix 19-A Project Special Provisions. All fiber optic splicing of ITS devices shall be performed in manholes; no fiber optic splicing shall be performed in pull boxes. Pull box and manhole spacing shall be as follows:

1. CDOT manholes shall be spaced a maximum of 1.5 miles apart and clustered in a group in common areas to accommodate future utility locates.
2. A pull box or manhole shall be installed at every ITS device location.
3. Between manholes, pull box spacing shall not exceed 1,000 feet.

The Contractor may reuse existing CDOT ITS pull boxes and manholes if they meet all requirements for the Project. The Contractor may add equipment such as racking or ladders in order to bring existing CDOT ITS pull boxes and manholes up to the requirements for the Project.

19.1.18.2 Material Requirements

All pull boxes and manholes shall be consistent with the requirements outlined in Appendix 19-A Project Special Provisions. Communications pull boxes shall be 24 inches x 36 inches x 24 inches or larger, as required. Electrical pull boxes shall be 11 inches x 18 inches x 12 inches.

19.1.19 ITS Device Cabinets

The Contractor's design shall utilize 332D cabinets at all VTMS and VMS locations. The Contractor's design shall utilize pole mounted Type 2 cabinets at all CCTV lowering device locations and all sign structure locations where a new cabinet is required without a VTMS or VMS. At all other ITS Device locations requiring a new cabinet, Type 2 ground mounted cabinets shall be used. At RMS locations, the existing ground mounted cabinets that are affected by the Project shall be reset.

19.1.20 Cabling and Conductors

The Contractor shall design conductors and cables utilizing a minimum of #12 AWG for all electrical conductors. All video-device control cables and connectors shall be designed in accordance with the manufacturer's recommendation and the CCTV manufacturer's signal attenuation requirements.

19.1.21 Conduit

19.1.21.1 Design Requirements

The Contractor shall design new and separate conduit systems (including all hardware, fasteners, and accessories) for communication and power control systems, where necessary. Existing communications backbone conduit may be reused where it is not impacted by the Project. Longitudinal conduits for the communications network shall be installed within the ROW and as close to the ROW Line as practical. The mainline communications run shall contain three 2-inch conduits for the CDOT backbone.

Conduits shall not exceed the NEC fill ratio requirements. When a lateral is installed within the backbone duct bank, an additional conduit shall be installed for the lateral. The following conduit colors shall be used so that the contents can be easily identified:

1. Orange: one 2-inch CDOT backbone conduit, as well as any additional lateral conduits within the backbone duct bank
2. Red: one 2-inch CDOT power conduit - Red
3. Blue with Orange Stripe: one 2-inch spare/empty conduits (for future Zayo fiber installation)

19.1.21.2 Material Requirements

All conduits shall meet CDOT specifications. The conduit shall be factory lubricated, low friction, high-density conduit constructed of virgin Schedule 80 high-density polyethylene resin. Conduit shall be capable of being coiled on reels in continuous lengths, transported, stored outdoors, and subsequently uncoiled for installation, without affecting its properties or performance.

Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel or cylindrical wire brush and blown out with compressed air. The Contractor shall provide an Existing Conduit Conditions Report showing the results of their cleaning and investigation work for all existing conduit to be utilized on the project. The report shall also provide a proposed method for repairing any damaged conduit segments, which must be reviewed and accepted by

CDOT prior to commencing repair work. All segments of the existing conduit shall be repaired by the Contractor.

19.1.22 Dedicated Short Range Communications Radios

These DSRC Radios will allow for vehicle-to-infrastructure communications.

19.1.22.1 Design Requirements

The Contractor shall prepare a design to locate DSRC Radio units in such a manner that a vehicle equipped with connected vehicle technology traveling in any lane, including the general purpose and express lane(s) in both directions, shall be able to have constant communications with at least one DSRC Radio throughout the Project limits. DSRC Radio units shall be installed no further than one half mile apart, or more frequent if necessary to meet these requirements. DSRC Radio units may be collocated on other ITS Poles or overhead sign structures where possible.

19.1.22.2 Material Requirements

The Contractor shall furnish new DSRC Radio units and any and all associated equipment necessary to achieve a fully-functioning system.

If colocation on an ITS Pole or sign structure is not feasible, a new ITS Pole shall be used.

19.2 Construction Requirements

The Contractor shall be responsible for furnishing and installing all ITS devices, the communications network, and the supporting infrastructure that is necessary to install and operate the ETC system components. The Contractor shall submit for Acceptance to CDOT all ITS devices and materials prior to installation by submitting product sheets.

The Contractor shall notify the designated CDOT representative upon installation or reinstallation of each ITS device and complete a CDOT data sheet. The Contractor shall be responsible for the integration of all ITS devices back to the CTMC. CDOT ITS shall be responsible for modifying the CTMS and Camera Cameleon software to incorporate the new devices.

Due to the risk of obsolescence, equipment should not be purchased or ordered more than six months prior to the installation date for any piece of equipment without prior written Acceptance by CDOT.

Refer to Appendix 19-A Project Special Provisions for construction requirements in addition to those described in the following Sections. Refer to Appendix 19-B Testing and Integration Plan for testing requirements.

19.2.1 Electrical Power

The Contractor shall make appropriate arrangements with the power service provider for installation or relocation of power service. The Contractor shall also be responsible for all costs of installing or relocating power sources, including involvement with the power service provider at locations for new services throughout the Project. Finally, the Contractor shall be responsible for all ongoing monthly electricity costs of all new services installed under this Project until Final Acceptance. CDOT will be responsible for ongoing electricity costs of existing ITS equipment.

The Contractor shall ensure the transition and reassignment of electrical service with the appropriate CDOT office so that there is no disruption in service.

19.2.2 Location and Protection of ITS and ETC Elements

The Contractor shall be responsible for locating all underground existing facilities to avoid or minimize conflicts with these facilities. If any facilities are damaged during construction, the Contractor shall be responsible for all repairs.

The Contractor shall install a grounding system and protection devices that are suitable for each specific ITS and ETC element.

19.2.3 Communications System

The Contractor shall furnish and install the fiber optic communications system and connect all ITS and ETC field elements to the system. Prior to performing any work that may impact existing ITS communications systems, the Contractor shall coordinate with CDO ITS.

The Contractor shall submit all network equipment cut sheets to CDOT for Acceptance. This submittal shall include, but not be limited to, the following project network equipment items:

- Ethernet Switches: Ciena 3930, Ciena 3931 (including mounting brackets and hardware), and Ciena 5160
- 1310nm Wavelength Small Form-Factor Pluggable Optic Modules
- Fiber Optic Attenuators
- All Network Licensing and Warranty Documentation
- Fiber Optic Splice Closures
- All materials associated with the above items for the installation of the Ethernet optical network

The Contractor shall have someone certified by Ciena configure all of the Ethernet switches installed by the Project. The Contractor shall submit a configuration plan to CDOT for Approval. The network equipment as part of this project requires both the Contractor's Ciena certified configuration specialist and Ciena technical network representatives to jointly configure each individual Ethernet switch, in addition to the configuration of the project network into the Colorado Transportation Management Center (CTMC) statewide intelligent transportation optical network. The Contractor shall provide, as part of the configuration plan, all required information to the CTMC for the Ethernet switches. This includes, but is not limited to, the Highway Mile Point of the Ethernet switch, the Project stationing of the Ethernet switch, and the devices to which the Ethernet switch is connected.

19.2.4 Variable Message Signs (VMS)

The Contractor shall be fully responsible for protecting the existing C-470 VMS during construction, including but not limited to transportation and installation of the sign as required for resets. The Contractor shall carry out all reinstallation and field-testing of each relocated unit. Any existing VMS that are not reused shall be salvaged and returned to CDOT ITS.

The Contractor shall be fully responsible for furnishing and installing all new VMS signs to the installation site and all damages that occur in the installation and delivery process. The VMS shall

be installed in accordance with manufacturer's recommendations. A qualified factory representative shall be available on site to ensure proper installation and testing.

Each VMS system shall be connected to the communication system using fiber optic laterals extended into the VMS controller cabinet. The Contractor shall notify Matthew Becker (303-512-5856), CDOT ITS, upon installation of each VMS.

In order to maintain the ability to provide VMS messages to C-470 during construction, the Contractor may reset existing cantilever structures for temporary VMS installation, if approved by CDOT Staff Bridge. The Contractor may not reuse existing VMS sign structures for permanent VMS installations.

19.2.5 Closed Circuit Television (CCTV)

The Contractor shall furnish all new CCTV cameras and carry out all installation or resetting, field-testing, burn-in of the system, and connection of each device to the communication system using fiber optic laterals. Existing CCTV cameras may be reused as long as they meet the appropriate material requirements outlined herein. Any existing CCTV cameras that are not reused shall be salvaged and returned to CDOT ITS.

At a minimum, the Contractor shall maintain existing CCTV coverage during construction.

19.2.6 Ramp Meter Stations (RMS)

The Contractor shall furnish all RMS-related equipment and carry out all installation, field-testing, and burn-in of the system. Existing RMS equipment may be reused as long as it meets the appropriate material requirements outlined herein. Any existing RMS equipment that is not reused shall be salvaged and returned to CDOT ITS.

In-pavement detector loops installed in new asphalt pavement shall be installed prior to the final lift of asphalt.

Each RMS system shall be connected to the communications system using fiber optic laterals.

19.2.7 Microwave Vehicle Radar Detectors (MVRD)

The Contractor shall furnish all new MVRD and carry out all installation or resetting, field-testing, and burn-in of the system per the manufacturer's recommendations and CDOT standards. Each device shall be connected to the communication system using fiber optic laterals. Existing MVRD units may be reused as long as they meet the appropriate material requirements outlined herein. Any existing MVRD units that are not reused shall be salvaged and returned to CDOT ITS.

19.2.8 Travel Time Indicators (TTI)

The Contractor shall furnish all TTI units and carry out all installation or resetting, field-testing, and burn-in of the system per the manufacturer's recommendations and CDOT standards. Each device shall be connected to the communication system using fiber optic laterals. Existing TTI units may be reused as long as they meet the appropriate material requirements outlined herein. Any existing TTI units that are not reused shall be salvaged and returned to CDOT ITS.

19.2.9 DTD Automatic Traffic Recorders (DTD ATR)

The Contractor shall furnish all DTD ATR-related equipment and carry out all installation, field-testing, and burn-in of all DTD ATR counting stations that are affected by the Project. All work shall be inspected by the Traffic Data Collection Unit (TDC) during installation. The Contractor shall test and operate the piezos and loops under actual traffic conditions.

In-pavement detector loops installed in new asphalt pavement shall be installed prior to the final lift of asphalt.

In order to maintain DTD ATR functionality during construction, the Contractor shall set up a temporary DTD ATR site utilizing a Wavetronix SmartSensor HD126 side-fire radar unit. A CDMA wireless modem shall be used for communications from the DTD central system to the field ATR. DTD will provide Phoenix Traffic Counter(s) for use at these temporary locations.

19.2.10 Doppler Radar

The Contractor shall coordinate with Jill Scott (303-512-5805) if any of the existing Doppler radar units currently installed along the corridor need to be relocated to new structures during construction.

19.2.11 Road Weather Information System (RWIS)

The Contractor shall furnish all RWIS related equipment and carry out all installation, field-testing, and burn-in of all RWIS that are affected by the Project. Each device shall be connected to the communication system using fiber optic laterals. Existing RWIS equipment may be reused as long as it meets the appropriate material requirements outlined herein, with the exception of the existing cabinets. New cabinets shall be furnished and installed by the Contractor. Any existing RWIS equipment that is not reused shall be salvaged and returned to CDOT ITS.

19.2.12 Variable Toll Message Signs (VTMS)

The Contractor shall be fully responsible for furnishing and transportation of all VTMS to the installation site and all damages that occur in the installation and delivery process. The VTMS shall be installed in accordance with manufacturer's recommendations. A qualified factory representative shall be available on site to ensure proper installation and testing.

19.2.13 Pull Boxes and Manholes

The Contractor shall furnish and install all pull boxes and manholes based on Appendix 19-A Project Special Provisions. Each location shall be easily accessible for maintenance purposes. Pull boxes and manholes shall not be placed in a known flood-prone area or drainage ditch. A fiber optic cable label shall be attached to each fiber optic cable located within a pull box or manhole. All fiber optic cable splices inside manholes shall be housed in a splice closure.

The Contractor shall clean out all existing CDOT ITS pull boxes that are reused as part of the Project by draining any water and removing any built up sediment down to the pea gravel. The Contractor shall clean out all existing CDOT ITS manholes that are reused as part of the Project by excavating one foot below the sump and refilling to sump depth with pea gravel

19.2.14 Salvaging of Materials

The Contractor shall salvage all existing ITS elements that are affected by the Project but are not reused. Salvaged equipment shall be returned to CDOT. Existing fiber cable, pull boxes, and manholes that are not reused shall be disposed of by the Contractor.

19.2.15 Cabling and Conductors

All cables shall be installed per the manufacturer requirements for each device or the requirements found in Appendix 19-A Project Special Provisions. The maximum conduit fill ratio for both new and existing conduits shall be in accordance with the NEC, latest version.

19.2.16 Conduit

For bores that contain more than one conduit, the conduit shall be bundled together and contained in a single bore.

Refer to Appendix 19-A Project Special Provisions for detailed construction requirements for all conduit installations.

19.2.17 Dedicated Short Range Communications Radios

The Contractor shall furnish all DSRC Radio units and carry out all installation, field-testing, and burn-in of the system per the manufacturer's recommendations and CDOT standards. Each device shall be connected to the communication system using fiber optic laterals with communications to a node building.

Any required FCC license(s) or registration for the DSRC Radio units shall be applied for and obtained by the Contractor.

The Contractor shall purchase and provide to CDOT any necessary software management tools for the DSRC Radio units. CDOT will be responsible for providing appropriate hardware to handle this software.

The Contractor shall be responsible for all testing of the DSRC Radio units, including equipment and software needed to perform the testing. All necessary equipment and software shall be transferred to CDOT's ownership after testing is complete and following project completion. Testing shall be performed per the US Department of Transportation's current version of "DSRC Roadside Unit Specifications" and OmniAir certifications, as described in more detail in the specifications provided in Appendix 19-A. Additionally, testing shall be performed per the manufacturer's recommendations.

The Contractor shall devise a testing plan to verify that the DSRC Radio units meet the operational availability requirements of 99.9%. This testing plan shall use vehicle probes and provide statistically significant results.

19.2.18 Testing and Integration

Testing and Integration shall be performed for all fiber optic cable, as well as new devices, reset devices, and existing devices connected to the fiber optic backbone according to all requirements outlined in Appendix 19-B Testing and Integration Plan. Testing shall demonstrate that all devices

operate per the manufacturer's specifications, as well as any additional requirements outlined in this document and Appendix 19-A Project Special Provisions.

19.2.19 Maintenance Period

The Contractor shall maintain the CDOT equipment and communications infrastructure the Contractor installs for a period of one year after Final Project Acceptance.

For the duration of the 1-year maintenance period, the Contractor shall appoint a contact qualified in installing, maintaining, troubleshooting, and repairing the ITS equipment and communications infrastructure. That person's credentials shall be presented to CDOT ITS staff for Approval.

The Contractor shall repair any malfunctioning or damaged devices and equipment within 24 hours of being notified of the problem by CDOT, with the exception of backbone communication and VTMS failures, which shall be repaired and restored within four hours of being notified of the problem by CDOT. The Contractor shall furnish all devices, equipment, and materials necessary to complete the repairs. If the devices and equipment are not repaired within the specified timeframe, CDOT will mobilize maintenance forces to fix the problem(s). The costs associated with such mobilization, labor, and equipment will be calculated and deducted from project retainage owed to the Contractor.

19.2.20 Training and Documentation

The Contractor shall provide CDOT personnel with instruction in the operation and maintenance of the hardware and software associated with the ITS equipment and infrastructure. The Contractor should assume up to 8 CDOT designated staff would attend these trainings. The Contractor shall also provide documentation for all ITS equipment.

19.3 ETC System Coordination

E-470 will be responsible for installing and integrating all ETC equipment at each toll point. E-470 will also be responsible for lane testing of the ETC equipment. The Contractor shall be responsible for providing traffic control when requested by the ETC System Integrator, including lane closures for ETC equipment installation.

19.3.1 Prerequisites for E-470 Integration

Prior to E-470's work to install and integrate all ETC equipment at each tolling location, the following conditions must be met:

- Cabinet backplane has been provided to the ETC System Integrator at least one month prior to tolling location installation.
- Barrier or guardrail has been installed (as needed).
- Tolling and UPS cabinets and pull boxes have been installed.
- Loop wire conduits have been installed.
- Final pavement has been placed where loops will be installed.
- Camera supports have been installed.
- Overhead structure and mounting brackets have been installed.

- Pull tape has been installed in all conduit runs from the ETC cabinet to the device locations.
- Permanent power and communications connections have been completed.
- The Contractor has performed all fiber and power testing to the toll locations, utilizing the testing procedures described herein to confirm functionality of the toll cabinets and lateral fiber.
- All debris has been removed from the site and the lanes have been swept to prepare for loop installation.
- Traffic management plans have been reviewed with the ETC System Integrator personnel. The express lanes shall be closed to allow for the ETC System Integrator to perform installation, mapping, and testing.
- Photos shall be sent to the ETC System Integrator for their review of readiness.
- A walkthrough shall be scheduled with the ETC System Integrator to verify the location is ready for installation and integration of ETC equipment.

Prior to E-470's work for lane testing of the ETC equipment, the following conditions must be met:

- E-470's work to install and integrate all ETC equipment, described above, must be complete.
- Traffic must travel through the final alignment of the toll point being tested. This can be accomplished through use of temporary traffic control.
- 12,000 vehicles must travel through the toll point over a minimum of a 24-hour period to account for a mix of traffic during both day and night.

Prior to E-470's Final Acceptance testing of the ETC equipment, traffic must be traveling through the final alignment for all toll points and final striping must be in place. See Reference Document 5 – E-470 Project Plan Requirements for Lane Installations for more information.

19.3.2 Scheduling Requirements

For ordering of ETC equipment, the Contractor shall assume in their schedule 75 business days from the date the equipment is ordered by E-470 until it is received. The Contractor shall give proper notice to E-470 to accommodate this time period. For configuring ETC equipment, the Contractor shall assume three weeks in their schedule.

The completion of the Punch List and Inspection Item will be completed by the HPTE as part of a separate contract.

E-470 requires at least two weeks of unrestricted access during favorable weather conditions at each tolling location to install and integrate the ETC equipment. Work at multiple toll points must be performed sequentially, not concurrently. The Contractor shall incorporate adequate time for this requirement to be met at all seven toll points into their schedule; if E-470 completes their work within two weeks at each toll point, no time extensions or schedule allowances will be granted to the Contractor. Once E-470 has installed the ETC equipment at a toll point, a preliminary inspection shall be performed by an HPTE representative.

E-470 requires at least one week to conduct the lane test at each toll point and work at multiple toll points must be performed sequentially, not concurrently. The Contractor shall incorporate adequate time for this requirement to be met at all seven toll points into their schedule; if E-470

completes their lane tests within one week at each toll point, no time extensions or schedule allowances will be granted to the Contractor.

In addition, the ETC System Integrator requires testing and evaluation under normal traffic patterns to perform final acceptance testing for assurance that the ETC back-office system is functioning correctly. The duration for E-470's Final Acceptance testing, is not part of the Prerequisite for E-470 Integration Milestone, shall run for a period not to exceed 70 business days from the date that the last tolling point lane acceptance testing is completed (i.e. 12,000 vehicle test) and be under normal traffic pattern data for all of the installed tolling points concurrently. Traffic must be provided in the express lane during this final acceptance testing period. However, lane closures could be possible for any additional work required as a result of the acceptance testing. Additionally, the Contractor shall provide advance notice to E-470 of any lane closures or other impacts to traffic through the toll points during the final acceptance testing period. The Contractor shall incorporate this final acceptance testing period into their schedule; if E-470 completes their work within the 70-business day timeframe, no time extensions or schedule allowances will be granted to the Contractor.

See Reference Document 6 – E-470 Flow Chart for more information on the ETC System Integrator's general process.

19.4 Deliverables

The Contractor shall submit the following to CDOT for Approval or Acceptance:

Deliverable	Acceptance, or Approval	Schedule
List of milestone dates for Tolling/ITS, including when Deliverables will be submitted	Approval	Within 90 days after issuance of NTP1
CCTV Coverage Plan	Approval	Concurrent with The Preliminary Design Plans (30%) Submittal
Preliminary ITS/ETC Design Plans	Acceptance	Concurrent with The Preliminary Design Plans (30%) Submittal
Temporary Communications & Device Plan	Approval	4 weeks prior to any temporary installations
Existing Conduit Conditions Report	Acceptance	4 weeks prior to conduit repair work
Network and Wiring Diagrams	Approval	Concurrent with The Pre-RFC Review Documents and Final RFC Documents Submittals
ITS and Toll Point Details	Approval	Concurrent with The Pre-RFC Review Documents and Final RFC Documents Submittals
Structural Design for VMS Structures and Toll Point Structures	Approval	Concurrent with The Pre-RFC Review Documents and Final RFC Documents Submittals
Cross Sections for CCTV Locations	Approval	Concurrent with The Pre-RFC Review Documents and Final RFC Documents Submittals
ITS/ETC Design Plans	Review/Acceptance	As Part of The Preliminary Design Plans (30%) Submittal, Pre-RFC Review Documents, and Final RFC Documents Submittals
Fiber Allocations and Splicing Diagrams	Approval	4 weeks prior to splicing
Method Statement and Cutover Plan	Approval	4 weeks prior to splicing
Supporting reports and design calculations including electrical calculations	Review/Approval	Concurrent with The Pre-RFC Review Documents and Final RFC Documents Submittals

Detailed ITS construction schedule	Approval	4 weeks prior to any ITS construction, including underground conduit and pull box infrastructure
Trenching & Boring Plan	Approval	1 week prior to any trenching or boring
Network Equipment Cut Sheets	Acceptance	Prior to ordering
ITS infrastructure product sheets and certifications	Acceptance	Prior to ordering and installation
Ciena Configuration Plan	Approval	4 weeks prior to Ciena configuration
Acceptance Test Procedures for VTMS and VMS	Acceptance	5 weeks prior to testing and integration
Testing Plan for the Network Design	Approval	5 weeks prior to testing and integration
Testing results	Acceptance	Within 5 business days after test period of each component
CDOT device data sheets	Acceptance	4 weeks prior to device integration
Maintenance Period Contact's Credentials	Approval	4 weeks prior to start of Maintenance Period
ITS equipment training, manuals, and associated documentation	Acceptance	Prior to final acceptance
As-built CAD documentation	Acceptance	Prior to final acceptance
Inspection and design report certification for reuse of existing VMS Cabinets	Review/Acceptance	As Part of The Preliminary Design Plans (30%), Pre-RFC Review Documents, and Final RFC Documents Submittals

The Contractor shall address all major aspects of this Work, including for individual construction areas/phases and stages, in the Traffic Management Plan (TMP), Traffic Control Plans (TCPs), and Methods of Handling Traffic (MHTs) according to Section 16 – Maintenance of Traffic.

Review by CDOT of the deliverables does not extend to accuracy of dimensions, means, methods, techniques, sequences, schemes, procedures of construction, or to safety precautions. Review does not relieve the Contractor of the responsibility for the correctness of their work.

19.5 Reference Documents

The following items have been included as Reference Documents:

1. Existing ITS Roll Plot
2. Tolling Roll Plot
3. Tolling Roll Plot for ARE #1
4. Existing Splice Diagrams

5. CDOT ITS Details
6. E-470 Project Plan Requirements for Lane Installations
7. E-470 Flow Chart
8. Existing Manhole and Pull Box Photos, Existing Device Photos, and County Line Node Building Photos
9. Schematic Diagram of E-470 Redundant Fiber Path

19.6 Project Special Provisions

Appendix A to this Section 19 includes the Project Special Provisions that shall be applicable to the Project.

This Section sets forth modifications to the CDOT Standard Specification for Road and Bridge Construction for design-build projects. The first section contains revisions to Division 100 of the Standard Specifications. The second section contains revisions to Divisions 200 through 700 of the Standard Specifications, as well as Standard Special Provisions applicable to the Project.

These Contract Provisions are a revised version of CDOT's Standard Specifications for Road and Bridge Construction, and contain requirements generally applicable to the Work to be performed by the Contractor. In certain cases, provisions in Section 100 of the Standard Specifications for Road and Bridge Construction have been superseded by other provisions of the Contract Documents. For ease of reference, this document uses the same Section numbers as the Standard Specifications for Road and Bridge Construction, and identifies provisions of the Contract Documents that have replaced or modified the standard clauses.

All references to "Engineer" that are incorporated into this Section refer to the Contractor's Engineer, unless the context requires otherwise. Non-capitalized terms, such as "work" that are defined in Book 1, Exhibit A, shall have the meanings defined therein unless the context requires otherwise. References to "approve, approval or approved" shall mean "Approve, Approval or Approved" as defined in Book 1, Exhibit A, when the approval is by CDOT or a division of CDOT. If the interpretation(s) pursuant to this paragraph are not clear, CDOT shall decide, in its sole discretion, how these terms shall be interpreted.

When these specifications describe actions, materials, means or methods that are required and that are qualified by phrases such as: "as directed by the Engineer", "when directed by the Engineer", "as determined by the Engineer", "with or without permission of the Engineer", "in the opinion of the Engineer", "unless authorized by the Engineer", "satisfactory to the Engineer", "as approved by the Engineer", or "unless another type is specified or is permitted with approval of the Engineer", such phrases shall be disregarded. If it is not clear whether a phrase should be disregarded, CDOT will make that decision in its sole discretion.

When these specifications refer to " Department", "Resident Engineer", "Agricultural Engineer", "Bridge, Construction or Maintenance Engineer", "TMC system inspector", "Concrete Engineer", "Project Engineer", "Materials Engineer", "Commissioner", "Structural Metals Engineer", "Department's Lighting Engineer", "Geotechnical Engineer" or any other specific CDOT special engineer, such reference shall mean the CDOT Project Director.

When these specifications use the term engineer relating to the approval of any activities involving the use of explosives, such term shall mean the CDOT Project Director.

When an approval or authorization of the Engineer or CDOT is required in these specifications for the use of alternative or substituted processes or components, the Engineer shall mean CDOT. If it is not clear whether a phrase involves the use of alternative or substituted processes, CDOT will make that determination in its sole discretion.

If these specifications refer to an approval of any correction or repair that deviates from the Contract requirements, the approval must be by CDOT. If it is not clear whether a specification involves a correction or repair that deviates from the Contract requirements, CDOT will make that determination in its sole discretion.

When these specifications provide that reports, records or other documents shall be submitted to CDOT or to the Engineer, such reports shall be made available to CDOT and do not have to be submitted unless either they are otherwise listed in the deliverables in the Contract Documents, or are required shop drawings, warranties, parts lists, instruction sheets or manufacturer's drawings or specifications. Such documents shall be submitted to CDOT as required by the specifications.

When these specifications require actions, materials, means or methods that are "either as indicated in the Plans or as designated by the Engineer," the Contractor shall disregard the phrase "or as designated by the Engineer."

When these specifications refer to the "Engineer" ordering work beyond the scope of work in the Contract, "Engineer" shall mean CDOT. Whenever in these specifications the Engineer may order work that results in additional costs to CDOT, the "Engineer" shall mean CDOT.

Any acceptances on behalf of CDOT or the State shall be performed by CDOT.

Any references to other standards, codes, or criteria, or to the latest version of other standards, codes, or criteria in Book 2 of the Contract Documents shall mean the latest version at the Proposal Due Date.

APPENDIX 19-A
PROJECT SPECIAL PROVISIONS FOR ITS AND ETC ELEMENTS

The CDOT 2011 *Standard Specifications for Road and Bridge Construction* controls construction of this Project. The following special provisions supplement or modify the *Standard Specifications* and take precedence over the *Standard Specifications* and plans.

Revision of Section 202 – Removal of Closed Circuit Television Pole
Revision of Section 202 – Removal of ITS Devices
Revision of Section 202 – Removal of Pull Box
Revision of Section 202 – Removal of Manhole
Revision of Section 210 – Reset CCTV Cameras
Revision of Section 210 – Reset Microwave Vehicle Radar Detector (MVRD)
Revision of Section 210 – Reset Travel Time Indicator
Revision of Section 210 – Reset Variable Message Sign
Revision of Section 604 – Manhole (Traffic Management System)
Revision of Section 612 – Location Markers
Revision of Section 613 – Electrical Conduit (Liquidtight Flexible Metal)
Revision of Section 613 – ITS Electrical Conduit
Revision of Section 613 – ITS Pull Boxes
Revision of Section 614 – Automatic Traffic Recording Station
Revision of Section 614 – Buffer Tube Fan-out Kit
Revision of Section 614 – Breakaway Tapered ITS Steel Pole
Revision of Section 614 – Closed Circuit Television Camera
Revision of Section 614 – Closed Circuit Television Pole with Lowering Device
Revision of Section 614 – Coarse Wavelength Division Multiplexing Module
Revision of Section 614 – Coarse Wavelength Division Multiplexing SFP
Revision of Section 614 – Communications Cabinet
Revision of Section 614 – Communications Cabinet (Type 2)
Revision of Section 614 – Controller Cabinet Foundation
Revision of Section 614 – Dedicated Short Range Communications (DSRC) Roadside Unit
Revision of Section 614 – Disincentive for ITS Offline Devices
Revision of Section 614 – Ethernet Router (5160)
Revision of Section 614 – Ethernet Switch (3930)
Revision of Section 614 – Ethernet Switch (3931)
Revision of Section 614 – Fiber Optic Cable (Single Mode)
Revision of Section 614 – Fiber Optic Pre-Connectorized Cable
Revision of Section 614 – Fiber Optic Splice Closure
Revision of Section 614 – Fiber Optic Termination Panel
Revision of Section 614 – Global Positioning System (GPS)
Revision of Section 614 – Grounding and Bonding
Revision of Section 614 – ITS System As Built Documentation
Revision of Section 614 – Microwave Vehicle Radar Detection (334)
Revision of Section 614 – Microwave Vehicle Radar Detection (Non-334)
Revision of Section 614 – Optical Attenuator
Revision of Section 614 – Optical Transceiver
Revision of Section 614 – Serial to IP Converter

Revision of Section 614 – Single Wavelength Coarse Wavelength Division Multiplexing (CWDM) Optical Filter
Revision of Section 614 – Small Form-Factor Pluggable – SFP
Revision of Section 614 – Test Fiber Optic Cable
Revision of Section 614 – Travel Time Indicator (TTI)
Revision of Section 614 – Uninterrupted Power Supply
Revision of Section 614 – Variable Message Sign (LED) (Overhead)
Revision of Section 614 – Variable Toll Message Sign (VTMS)
Revision of Section 614 – Weather Monitoring System

REVISION OF SECTION 202
REMOVAL OF CLOSED CIRCUIT TELEVISION POLE

Section 202 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

This work consists of removing and disposing of existing Closed Circuit Television (CCTV) poles and related materials.

CONSTRUCTION REQUIREMENTS

CCTV camera poles designated to be removed shall be removed along with any associated hardware, conduit, cabling, and other equipment.

The foundation shall be removed to a depth of 1 foot below natural ground surface, or as necessary to accommodate the proposed construction. Waste material shall be removed and the remaining foundation shall be backfilled with native material.

REVISION OF SECTION 202
REMOVAL OF ITS DEVICES

Section 202 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

This work consists of removing ITS devices, cabinets, communications equipment, and related materials, and salvaging them to CDOT ITS staff at the CTMC (425 C Corporate Circle, Golden, CO 80401).

CONSTRUCTION REQUIREMENTS

ITS devices designated to be removed shall be removed along with communications equipment, cabinets, mounting hardware and brackets, conduit, cabling and electrical equipment.

All ITS devices shall be carefully removed and delivered to CDOT ITS staff at the CTMC in Golden, CO.

For ITS devices designated for removal that are being replaced with new ITS devices, the Contractor shall have the new ITS device in place before the existing ITS device is taken out of service. Downtime for transition from old ITS device to new ITS device shall be limited to the period of time set forth in Revision of Section 614 – Disincentive for ITS Offline Devices.

REVISION OF SECTION 202
REMOVAL OF PULL BOX

Section 202 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

This work consists of the removal and disposal of pull boxes.

CONSTRUCTION REQUIREMENTS

The Contractor shall remove and dispose of all pull boxes which are identified as such on the project.

Removal of Pull Box shall include removal of pull box, concrete collars, any backfill necessary to match grade, and other incidental materials. At locations where the pull boxes are being replaced or the existing cabling and materials within the pull box are not being abandoned, Contractor shall take appropriate precautions and exercise care to avoid damaging any existing cabling and equipment within the pull box.

REVISION OF SECTION 202
REMOVAL OF MANHOLE

Section 202 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

This work consists of the removal and disposal of manholes.

CONSTRUCTION REQUIREMENTS

The contractor shall remove and dispose of all manholes which are identified as such on the project.

Removal of Manhole shall include removal of manhole, cover, frame, adapter, concrete collars, any backfill necessary to match grade, and other incidental materials comprising such item.

REVISION OF SECTION 210
RESET CCTV CAMERAS

Section 210 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

This work consists of resetting Closed Circuit Television (CCTV) cameras and related materials. All CCTV cameras to be reset shall be carefully removed, stored, and reinstalled in a manner that avoids loss or damage. All infrastructure shall be in place for the reset CCTV location before the existing CCTV is taken out of service.

MATERIALS

The Contractor shall reset the existing CCTV camera and related materials. Any new electrical and communications conduit, cabling and equipment necessary to restore the CCTV service at the new location shall be provided as part of this work.

CONSTRUCTION REQUIREMENTS

CCTV cameras designated to be reset shall be relocated along with communications and electrical equipment. Any new electrical and communications equipment necessary to restore the CCTV service at the new location shall be installed. Equipment and materials shall be cleaned prior to being reset. Contractor shall verify CCTV functionality prior to reset.

Downtime shall be limited to the time periods set forth in the Cutover specification. The Contractor shall coordinate this work with Jill Scott at CDOT ITS at (303) 512-5805.

The CCTV camera shall be installed in accordance with these specifications and in accordance with manufacturer's recommendations.

See project specific Testing & Integration Plan for additional requirements for reset CCTV cameras.

REVISION OF SECTION 210
RESET MICROWAVE VEHICLE RADAR DETECTOR

Section 202 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

This work consists of resetting Microwave Vehicle Radar Detector (MVRD) systems.

MATERIALS

The Contractor shall reset the existing MVRD and related materials. Any new electrical and communications conduit, cabling and equipment necessary to restore the MVRD service at the new location shall be provided as part of this work.

CONSTRUCTION REQUIREMENTS

The MVRD system shall be removed, relocated and integrated per the manufacturer's standards and recommendations. The MVRD system must be fully installed and integrated over the fiber optic network, and testing must be accepted by CDOT ITS.

Downtime shall be limited to the time periods set forth in the Disincentive for ITS Offline Devices specification. The Contractor shall coordinate this work with Jill Scott at CDOT ITS at (303) 512-5805.

The MVRD system shall be installed in accordance with these specifications and in accordance with manufacturer's recommendations.

See project specific Testing & Integration Plan for additional requirements for reset MVRDs.

REVISION OF SECTION 210
RESET TRAVEL TIME INDICATOR

Section 202 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

This work consists of removing and resetting travel time readers, antenna, conduit, cabling, and all other associated items of the Travel Time Indicator (TTI) system.

CONSTRUCTION REQUIREMENTS

The TTI system shall be relocated and mounted per the manufacturer's standards and recommendations. The TTI system must be fully wired, operational, connected to the fiber network, able to communicate, and must be accepted by CDOT ITS. TTI systems to be reset shall be aimed to pick up traffic in the general purpose lanes only and shall not pick up traffic in the managed lane. Any additional mounting hardware required shall be included in the cost of the reset.

Downtime shall be limited to those requirements set forth in the Cutover specification. The Contractor shall coordinate this work with Jill Scott at CDOT ITS at (303) 512-5805.

The TTI system shall be installed in accordance with these specifications and in accordance with manufacturer's recommendations.

See project specific Testing & Integration Plan for additional requirements for reset TTIs.

REVISION OF SECTION 210
RESET VARIABLE MESSAGE SIGN

Section 210 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of resetting a full, overhead Variable Message Sign (VMS). Major work elements include removing and resetting the existing VMS and controller cabinet to a new location.

MATERIALS

The Contractor shall reset the existing VMS and related materials. Any new electrical and communications conduit, cabling and equipment necessary to restore the VMS service at the new location shall be provided as part of this work.

CONSTRUCTION REQUIREMENTS

The VMS shall be relocated and mounted per the manufacturer's standards and recommendations. The VMS must be fully wired, operational, connected to the fiber network, able to communicate with the Colorado Transportation Management Software (CTMS), and must be accepted by CDOT ITS. The Contractor shall test the VMS to ensure all equipment is fully operational both before and after each reset.

If the existing VMS installation has a ground mounted cabinet, a polymer concrete cabinet foundation shall be furnished and installed to house the existing cabinet at its new location per the CDOT standard plans.

The Contractor shall maintain operability of the VMS sign during construction. Construction for the temporary installation shall include a new caisson, power, communications, and all other work necessary to fully relocate the VMS and keep in service throughout construction until the permanent VMS is ready.

See project specific Testing & Integration Plan for additional requirements for reset VMS.

REVISION OF SECTION 604
MANHOLE (TRAFFIC MANAGEMENT SYSTEM)

Section 604 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

Manhole (Traffic Management System) shall include the installation of manholes for the Traffic Management System at locations approved by the Engineer.

MATERIALS

Manhole (Traffic Management System) shall be pre-cast concrete, circular or square, with a base and cast iron frame ring and cover. Each manhole, frame, and cover shall conform to American Association of State Highway and Transportation Officials (AASHTO) HS20-44. Manholes shall be capable of accepting concrete grade rings to add height to raise the ring and cover to a future finished grade.

Pre-cast units shall be provided with factory-installed knockouts that will permit the installation of a minimum of six two-inch conduits. The factory-installed knockouts shall be at a depth of three feet below the top of the manhole. The manhole shall have a detachable cover that has a skid-resistant surface and have the words “CDOT COMM” physically impressed on its top. The cover shall be attached to the manhole body by screw-in bolts.

Each Manhole shall include all hangers and hooks that accommodate all proposed fiber and communication cabling. Fiber management hangers and hooks for fiber coils and splice canisters shall be of sufficient quantity to hang each backbone and lateral cable installed in the manhole separately on its own set of hangers.

CONSTRUCTION REQUIREMENTS

The Contractor shall neatly excavate the site of manhole installation. A minimum of 12 inches of ¾ inch granite-gravel shall be placed below the manhole.

In pavement and sidewalks, the top of the manhole shall be flush with the existing grade. Outside of pavement and sidewalks, the top of the manhole shall be two inches above existing grade.

Backfill around the manhole excavation shall conform to Section 206, Structure Backfill (Class 2).

Fiber optic cable coils shall be tied to each cable rack with plastic cable ties. The Contractor shall coil the fiber cable per the manufacture’s recommendations. If hangers are not factory installed in the manhole, the bolts shall be installed in the manhole walls by means of either an epoxy compound or expansion type fitting. Conduit that enters the manhole base shall have sweeps attached so conduit entrance is elevated a minimum of six inches above the bottom of the manhole.

Backfill for Manhole (Traffic Management System) shall conform to Section 206, Structure Backfill (Class 2).

REVISION OF SECTION 612
LOCATION MARKERS

Section 612 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

Contractor shall furnish and install location markers for identifying fiber optic conduit and other utility conduit at locations shown on the plans.

MATERIALS

Location Marker (Fiber Optic) (Dome) shall be made of non-conductive high-density polymer, and shall be integrally white in color with an orange cap. All colors shall be stabilized against ultraviolet light such that they will not fade under continuous exposure to direct sunlight and conform to the American Public Works Association (APWA) Uniform Color Code for delineating underground utility lines. The marker shall retain dimensional stability in temperatures ranging from -40º F to 175º F. In some instances when markers are installed on National Forest Service Lands the location marker shall be brown (Federal Standard Color 20059 or approved by Project Engineer) in color.

The Location Marker (Fiber Optic) (Dome) shall include a label with CDOT contact information and the designation of “FIBER OPTIC CABLE”. The label shall have black lettering on an orange background. The label shall include the highway milepost of the Pull Box or Manhole (TMS). The mile post shall be to the nearest hundredth mile. This label shall be placed below the “FIBER OPTIC CABLE” warning label. When markers are installed on National Forest Service Lands the dome marker label shall have black lettering on a brown (Federal Standard Color 20059 or approved by Project Engineer) background. The Contractor shall provide the label submittal to the Project Engineer.

Location Marker (Utility) (Flat Slat) shall be made of fiberglass reinforced composite, and shall be orange or red in color. The marker shall retain dimensional stability in temperatures ranging from -40º F to 175º F. In some instances when markers are installed on National Forest Service Lands the location marker shall be brown (Federal Standard Color 20059 or approved by Project Engineer) in color.

The Location Marker (Utility) (Flat Slat) shall include a label with CDOT contact information and the designation of “ELECTRICAL CABLE” or “TELEPHONE CABLE”. The label shall have black lettering on a red background for electrical and black lettering on an orange background for telephone. In some instances when markers are installed on Forest Service Lands the flat marker label shall have black lettering on a brown (Federal Standard Color 20059 or approved by Project Engineer) background. The Contractor shall provide the label submittal to the Project Engineer for approval.

Concrete footing for dome marker shall be 18 inches x 18 inches x 12 inches. Concrete footing shall be Concrete Class B and shall be in accordance with Section 601.

CONSTRUCTION REQUIREMENTS

Location Marker (Fiber Optic) (Dome) shall be installed at all Pull Box and Manhole (Traffic Management System) locations that contain fiber optic cable. Intermediate markers shall be installed at 1000-foot spacing along each conduit run.

Location Marker (Utility) (Flat Slat) shall be installed at utility pull box and manhole locations and utility point of service to identify both electric and telephone communication lines. Contractor shall designate the utility line with a marker installed mid-point between the utility point of service and the device.

REVISION OF SECTION 613
ELECTRICAL CONDUIT (LIQUIDTIGHT FLEXIBLE METAL)

Section 613 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work includes furnishing and installing new liquidtight flexible metal conduit (LFMC) and fittings for use with fiber optic cable, electrical conductors, and communications cabling. All underground-to-aboveground and aboveground conduit installations shall utilize LFMC.

MATERIALS

All materials furnished, assembled, fabricated, and installed under this item shall be new, Underwriters Laboratories (UL) listed, corrosion resistant, and National Electric Code (NEC) compliant.

LFMC shall meet UL safety standard UL 360 – *Liquid-Tight Flexible Metal Conduit.*

The LFMC shall be rated for use in wet locations.

For below ground to above ground transitions, LFMC to Polyvinylchloride (PVC) coupling and LFMC to High Density Polyethylene (HDPE) coupling shall be listed for use.

CONSTRUCTION REQUIREMENTS

Prior to installation, the contractor shall submit technical data sheets for all conduit types, couplings, fittings, elbows, L-bends, mounting hardware, conduit plugs, and sealing plugs to the Engineer for written approval.

LFMC shall be installed in all below ground to above ground conduit transitions. Below ground, the contractor shall couple the LFMC conduit to the below ground conduit using approved coupling technology that is listed for use with LFMC.

Above ground LFMC shall be installed between pole-mounted communications cabinets and device poles. LFMC shall be installed between Variable Message Sign (VMS) housing and the VMS support structure. For above ground LFMC entries into cabinets, poles, and VMS housings, the contractor shall use fittings listed for use with LFMC. At entries into cabinets, poles, and VMS housings, the Contractor shall ensure that the entry hole is free from sharp edges and burrs.

The Contractor shall use factory drilled entries for connection of LFMC to cabinets, poles, and VMS housings. If the LFMC is to be used on an existing structure or cabinet on which no factory drilled entry exists, the Contractor shall receive approval from the Project Engineer prior to field drilling cabinets, poles, and VMS housings.

At field drilled steel poles, the Contractor shall repair all damaged galvanizing by hot dip or metallizing process as described in American Society for Testing and Materials (ASTM) A780 or shall paint with one full brush coat of a zinc-rich paint meeting Military Specification Department of Defense (DOD) DOD-P-21035A. Spray can applications of zinc will not be allowed.

LFMC installation shall conform to the requirements of NEC Article 350 LFMC.

LFMC shall be secured and supported per NEC Article 350.30.

REVISION OF SECTION 613
ITS ELECTRICAL CONDUIT

Section 613 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work includes furnishing and installing new High-Density Polyethylene (HDPE) and Polyvinyl Chloride (PVC) electrical conduit and fittings for use with fiber optic cable, electrical conductors, and communications cabling.

MATERIALS

All materials furnished, assembled, fabricated, or installed under this item shall be new, Underwriters Laboratories (UL) listed, corrosion resistant, and National Electric Code (NEC) compliant. Materials shall be submitted to the Project Engineer for approval.

Electrical conduit shall be Schedule 80. Electrical conduit and fittings shall be UL listed.

HDPE conduit and fittings shall be certified by the manufacturer as meeting American National Standards Institute (ANSI) ANSI/UL 651A. PVC conduit and fittings shall be certified by the manufacturer as meeting ANSI/UL 651. The manufacturers shall be International Organization for Standards (ISO) ISO 9001 compliant.

All HDPE conduit shall be factory lubricated, low-friction, high-density conduit constructed of virgin high-density polyethylene resin. HDPE conduit shall be capable of being coiled on reels in continuous lengths, transported, stored outdoors, and subsequently used for installation, without affecting its properties or performance.

Each conduit shall be equipped with a pull tape. The pull tape shall have a minimum tensile strength of 1800 pounds and be of a design and manufacture that prevents cutting or burning into the conduit during cable installation. The pull tape shall include a continuous 22 gauge tracer wire. Splices in the pull tape and tracer wire may occur inside manholes and pull boxes and shall not be permitted inside conduit.

A minimum 12 gauge tracer wire shall be included in conduits containing fiber optic cable.

CONSTRUCITON REQUIREMENTS

All conduit and fittings installation shall conform to the NEC.

Electrical conduit that is installed using a trenchless technology such as boring shall be HDPE. Electrical conduit that is installed using direct burial methods such as plowing, open trenching, or other excavation methods shall be PVC or HDPE.

Prior to construction, the Contractor shall submit a trenching and boring plan to the Engineer for approval. The plan shall show the limits of the planned work areas and the areas of anticipated disturbance. All disturbances outside the planned work areas created by Contractor's operations shall be restored to their original condition at the Contractor's expense.

During construction operations, the contractor shall maintain boring logs that include the depth at specific distances along the bore. Boring logs shall be submitted on a weekly basis.

Excavations and conduit installation shall be performed in a continuous operation. All trenches shall be backfilled by the end of each shift. Material from trenching operations shall be placed in a location that will not cause damage or obstruction to vehicular or pedestrian traffic or interfere with surface drainage.

The Contractor shall be responsible for damage due to over-excavating a trench and heaving damage to the existing asphalt and concrete mat caused by equipment directly and by dislodging rocks or boulders. All damage from over-excavation and heaving shall be repaired at the Contractor's expense. The Contractor shall bear the cost of backfilling all over-excavated areas with the appropriate backfill material approved by the Engineer.

The Contractor shall restore all surface materials to their original condition or better, including but not limited to pavement, sidewalks, sprinkler systems, landscaping, shrubs, sod, and native vegetation that is disturbed by the conduit installation operation. All repairs shall be included in the cost of the conduit.

The Contractor shall use UL listed splice couplings that comply with the NEC. The coupling technology used to connect conduit ends shall require no special tools and form a watertight, airtight seal. The breaking force between segments shall exceed 250 pounds. Conduit splices shall be kept to a minimum and all such locations shall be approved and inspected by the Engineer and the authority having jurisdiction. Additional pull boxes shall not be substituted for conduit splices.

Conduit plugs that are watertight, removable, mechanical, and equipped with a tie rope for connection to a pull rope and pull tape shall be supplied and installed in all open conduit ends immediately following conduit installation. Conduit shall be plugged at all termination points including, but not limited to pull boxes, manholes, controller cabinets, structures, poles, and node buildings. Conduits containing cable shall be plugged with durable and reusable split type plugs, fabricated without metallic parts. The plugs shall allow easy removal and reinstallation around in-place cables. Split type plugs shall provide a watertight and airtight seal of at least 22 pounds per square inch. They shall be installable by hand without using tools and without damaging the cable. All plugs shall be correctly sized to fit the conduit being plugged.

All conduits shall use sweeps to elevate the buried conduits to the final grade within a pull box or manhole. The sweeps shall be terminated within the pull boxes and manholes to allow for easy installation and removal of conduit plugs. The sweeps shall be set above the ground surface of the inside of the pull box at a height that does not interfere with coiling of the fiber optic cable.

All conduits terminating in a pole or sign structure shall extend to a point 6 inches below the handhole in the pole or structure.

All conduit runs containing fiber optic cable shall have a limited number of bends. The sum of the individual bends on a single conduit run between any two pull points shall not exceed 270 degrees. No individual bend shall exceed 90 degrees. All conduit bends shall have a minimum acceptable radius of 48 inches for 90 degree bends and for conduit containing fiber optic cable, and 24 inches for all other bends. HDPE conduit minimum bending radius shall conform to Table 354.24 in the NEC.

New conduits may be installed into existing pull boxes, manholes, and cabinet bases, and the Contractor shall carefully excavate around the existing facility and install the new conduit as shown on the plans. The Contractor shall not damage the existing facility or its contents. If the existing conduit, pull box, lid and concrete collars are damaged during conduit installation, the Contractor shall restore the damaged item or section to current CDOT requirements at no additional cost to the project.

Conduit shall always enter a pull box, manhole, cabinet base or any other type structure from the direction of the run only.

All conduit ends shall be free from sharp edges and burrs.

REVISION OF SECTION 614
ITS PULL BOXES

Section 613 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

Contractor shall furnish and install fiberglass reinforced, polymer concrete pull boxes and concrete aprons.

MATERIALS

Pull boxes shall be verified by a 3rd Party Nationally Recognized Independent Testing Laboratory as meeting all test provisions of American National Standards Institute/Society of Cable Telecommunications Engineers (ANSI/SCTE) 77, 2013 Specification for Underground Enclosure Integrity, Tier 22 rating. Pull boxes shall be Underwriters Laboratories (UL) listed. Certification documents shall be submitted with material submittals.

Each pull box shall have an Electrical Marker System (EMS) locator disk manufactured into the lid for communication line locating. The locator disk shall be compatible with a CDOT cable locator and utilize the APWA Uniform Color Code standard for visual reference, if disk is observable on the exterior of the lid. The locator disk shall utilize the proper locate frequency for the pull box type.

Pull boxes 24 inches by 36 inches and larger shall have removable split lids with a removable metal center support beam. Lid segment weight shall not exceed 100 pounds.

Pull box removable lids shall be provided with a skid-resistant surface and have the words “CDOT FIBER” or “CDOT POWER”, as well as “EMS MARKER EMBEDDED IN COVER” and the tier level rating cast into the surface. Painting of words shall not be accepted. The cover shall be attached to the pull box body by means of 3/8 inch x 7 inch lag thread hex head stainless steel bolts.

One piece lids shall have a minimum of two lift slots per lid, while split lids shall have a minimum of one lift slot per lid. Lift slots shall be rated for 3000 pounds.

Test point locations shall be integrated into the pull box lids to provide for attachment of test leads of various connector types for underground conduit tracing. The minimum number of test point locations shall equal the number of conduit banks entering the pull box, up to a maximum of five test points. Pull boxes with split lids shall have the test points on one split lid section only. Pull box lids shall be furnished with 3/8 inch x 1/16 inch deep recesses at locations adjoining each test point for the application of direction arrow symbols indicating the direction of underground conduit exiting the pull box. Recesses shall be thoroughly cleaned with alcohol prior to applying arrow symbols.

Wire mesh shall be installed in a manner to completely surround the box. The wire mesh shall meet the material standard ANSI/American Society of Testing and Materials (ANSI/ASTM) A555-79 and made of T-304 stainless steel, 0.025 inch wire diameter minimum and shall have a spacing of 10 mesh per inch.

Pull boxes installed in dirt or landscaped areas shall have a Class B concrete apron or a pre-cast polymer concrete apron. Class B concrete shall be in accordance with Section 601.

The pre-cast polymer concrete apron shall be non-metallic, non-conductive, and UV resistant, and shall include two lifting slots for placement in the field. The pre-cast polymer concrete apron shall be a minimum of 4 inches deep and shall extend a minimum of 11 inches from each side of the pull box. The gap between the pre-cast polymer concrete apron and outer wall of the pull box shall be a maximum of ½ inch.

Pull Box (Surface Mounted) shall be aluminum type with a hinged front door and have at least a National Electrical Manufacturers Association (NEMA) 3R rating. The hinged door shall be provided with both a weather tight seal and an aluminum hasp. Surface mounted pull boxes shall be approved by the Engineer.

CONSTRUCTION REQUIREMENTS

A minimum of 12 inches of ¾ inch granite-gravel shall be installed as a base for the pull box. The granite-gravel shall be free of dirt and debris and spread evenly to facilitate a level base for the pull box. The Contractor shall ensure that sufficient compaction is met prior to the installation of granite-gravel to alleviate future settling.

Wire mesh shall be installed to completely surround the box. The wire mesh shall be installed prior to the installation of the pull box above the bed of ¾ inch granite-gravel and extending one foot past the outer edges of the concrete apron. The wire mesh shall be gently cut to allow only the entrance of the conduit through at the bottom of the box. All openings cut in the wire mesh that are larger than the diameter of the conduit shall be covered with additional wire mesh in a manner to completely surround the pull box with wire mesh.

Tracer wire shall be attached to the trace test points on the underside of the pull box lid. Each trace wire shall be attached to an individual trace point, no two wires shall be attached to the same point. The Contractor shall coil an additional 6 feet of tracer wire inside the pull box to ensure that the tracer wire will not disconnect from test points when the lids are removed.

At pull boxes installed in dirt and landscaped areas, the Contractor shall install a concrete apron or a pre-cast polymer concrete apron around the edges of the pull box. Three sides of the concrete apron shall measure 12 inches wide by 6 inches deep and one side shall measure 18 inches wide by 6 inches deep. The apron side measuring 18 inches wide by 6 inches deep shall be located on the edge of the pull box furthest from the roadway, and shall contain a 4 inch diameter round knockout for fiber optic marker installation. Pull boxes shall not be installed above the grade of the apron. The concrete apron shall have a 1 percent slope away from the top of pull box to allow for drainage.

Surface mounted pull boxes shall be mounted on or embedded into hard surfaces such as bridge decks, concrete barriers, retaining walls, or buildings, as approved by the Engineer. Surface mounted pull boxes shall be attached using 3/8-inch epoxy anchors or other methods approved by the Engineer. Surface mounted pull boxes shall not be used for ground installations. Pull rope and tracer wire shall be installed in surface mounted pull boxes.

REVISION OF SECTION 614
AUTOMATIC TRAFFIC RECORDING STATION

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of replacing any and all existing Division of Transportation Development (DTD) Automatic Traffic Recording (ATR) Station equipment that is impacted during construction and furnishing and installing a temporary ATR station to be used during construction. This also includes providing a cabinet to house all components for the ATR station.

The Contractor shall furnish and install any in-pavement loops, piezoelectric axle sensors (piezo), conduit and pull boxes for the existing permanent DTD ATR Stations that are impacted during the construction.

The Contractor shall also furnish and install temporary DTD ATR stations which will be used to provide traffic volume and classification information while the permanent ATR stations are out of service. The temporary ATR stations shall be installed and operational prior to any shift in traffic. The temporary ATR stations will be installed on temporary poles as close as practically possible to the existing ATR stations. Each temporary ATR station will consist of a Wavetronix SmartSensor HD126 side-fire radar unit, CDMA cellular modem, pole mounted cabinet, and associated equipment, to make a complete temporary CDOT DTD ATR Station. CDOT DTD will provide 1- 4 lane Phoenix Traffic Counter, 2 cables to interface the counter to the Click 100 and 1 cable to connect the counter to the modem for each temporary ATR station. All equipment for the temporary ATR shall be salvaged to CDOT DTD at the end of the project.

The Contractor shall coordinate all work with Mike DelCupp, Traffic Data Collection Manager, at 303-757-9816.

MATERIALS

1) **Permanent ATR Station -** the permanent ATR Station materials shall include a cabinet, cabinet foundation, loop detector wire, and piezos. The cabinet, cabinet foundation, loop detector wires, and piezos shall meet the following specifications:

   - NEMA Type M cabinet with one outlet, fan, thermostat, 20 amp breaker, and a shelf.
   - Each communications cabinet shall include a polymer concrete or poured concrete pad that extends at least 2'-6" beyond the cabinet base on each cabinet door side and at least 6" beyond the cabinet base on the other two sides. The cabinet base shall be sealed around the conduits.
   - Loop detector wire shall consist of specified loop wire encased in ¼ inch OD, 3/16 inch ID vinyl or polyethylene tubing. (14-1/C Loop detector cable 19 STR. PVC/Nylon/PVC Tube 600v IMSA 51-5)
   - Loops shall be sealed with a two-part self-curing, self-bonding weatherproof epoxy approved for sealing loops. Loops shall be 6 feet by 6 feet.

- The piezo shall be class II and 6 feet in length. The piezo shall have sufficient lead in cable, so the lead in cable can be pulled into the cabinet without splicing.
- Grout or epoxy for the installation of the loops and piezos shall conform to manufacturer's recommendations.

2) Temporary ATR Station - the temporary ATR Station materials shall include:

(a) *Wavetronix SmartSensor HD126 Side-fire Radar Unit*: The radar detection unit and all mounting hardware, manufacturer configuration software, power/communication cable, detection unit power supply, serial surge suppression, and any additional hardware necessary for a complete and functional installation shall be provided. The Contractor shall furnish and install the following required items, which shall all be DIN rail mountable, for the Wavetronix radar detection unit:

- Fuse block,
- Wavetronix Series 100 Click module,
- Mini power supply and circuit breaker,
- Wavetronix Series 205 Click module, and
- Wavetronix Click 200 for the serial surge suppressor.

The surge suppressor shall be DIN rail mountable with hot swappable protected busses. The surge suppressor shall provide protection for RS-232, RS-485, and DC power to the radar detection unit. Wiring for the surge suppressor shall be by means of pluggable screw terminals and include unprotected RS-232 and RS-485 communications connectors. The surge suppressor shall have a minimum operating temperature range of -29 to 165˚F up to 95 percent relative humidity.

Manufacturer configuration software shall be the latest production version and allow for device discovery, configuration, and troubleshooting.

Power/communication cable shall be the manufacturer's recommended cable for functional operation of the radar detection unit.

(b) *CDMA Wireless Modem*: The CDMA cellular modem shall be furnished, installed, configured, and tested, and the Contractor shall establish communications from the DTD central system to the field ATR. The Contractor shall be responsible for the cellular bill and payment during construction.

(c) *Pole Mounted Cabinet*: The pole-mounted cabinet shall be NEMA 4R rated and shall be sized adequately to house all of the ATR Station components, such as the counter, CDMA modem, Wavetronix equipment, power supplies, cabling, and wiring. The cabinet shall be a minimum of 20 inches x 20 inches with a 120 volt outlet.

(d) *Equipment Supplied by CDOT DTD*: CDOT DTD will provide the following equipment that will be needed for each fully functional temporary ATR site: 1 – 4 lane Phoenix Traffic Counter, 2 cables to interface the counter to the Click 100 and 1 cable to connect the

counter to the modem. The Contractor shall contact Mike DelCupp at 303-757-9816 for the equipment supplied by DTD.

CONSTRUCTION REQUIREMENTS

(a) *General.* A minimum of five days prior to installation for both the permanent and temporary ATR, the contractor shall submit a schedule of installation activities including alternative scheduling to the CDOT Project Manager and the Traffic Data Collection Manager (Mike DelCupp 303-757-9816; mike.delcupp@state.co.us). The temporary ATR shall be installed and fully functional prior to any shift in traffic. The installation instructions from the manufacturer shall also be submitted for approval. Installation shall not begin until approval has been received from CDOT.

For the permanent ATR, the Contractor shall install the loops and piezos as close to the existing detection equipment locations as possible. Exact locations, dimensions, and configurations may vary based on site conditions, and shall be as approved by CDOT.

All work will be inspected by the Traffic Data Collection Unit (TDC) during installation.

The permanent and temporary ATR shall be installed in accordance with these specifications, the project details, and in accordance with manufacturer's recommendations.

(b) *Installation of loops.* Loops shall be centered in the travel lane with two sides parallel to lane striping. The saw cut for the loops shall be made 3/8 inch wide and 3-½ inches deep. The saw slot shall be as straight as possible and shall not vary more than ½ inch when checked with a straightedge. No more than one set of loop lead wires shall be placed in one saw slot. Saw cuts shall be hydro-blasted with a mixture of water and air and then blown free of water and debris with compressed air, using a large capacity air compressor of at least 150 CFM. The cuts shall be dry prior to placement of loop wire.

The Contractor shall locate all buried utilities, which may interfere with the planned location of the ATR site. The Contractor shall contact the Utility Notification Center of Colorado (UNCC) at 811 or 1-800-922-1987 for location of member utilities at least three working days prior to any excavation, not including the day of actual notice.

The Contractor shall also locate non-member utilities, such as storm sewer and ditch. Any utility conflicts encountered with the proposed installation shall be brought to the attention of the Engineer

After the saw slot is cleaned of debris and dried, the wire shall be placed for the loop by pushing it into the slot with a blunt non-metallic object. A screwdriver or other sharp tool will not be permitted. Care shall be used to avoid abrading or damaging the insulation.

All loop corners shall be rounded using a 1-½ inch hole drilled to a minimum depth of 3-½ inches. Loop leads shall be drilled when leaving the roadway surface at a 45 degree angle 8 inches from pavement edge out through the side or bottom of roadway, the drilled hole shall be no larger than ¾ of an inch. All holes shall be spaced a minimum of three inches from one another. No more than one set of loop lead wires shall be placed in one drill hole.

One continuous length of loop wire shall be used for each loop from pull box or cabinet around the loop with 4 turns and back to the pull box or cabinet with no splices. The wires shall be seated in the bottom of the saw slot. A ½-inch backer-rod shall be installed to insure wires do

not float to the surface during grouting. Backer-rod shall be installed in 4 to 6 inch pieces with 1 to 2 foot gaps in-between, to insure the sealant will come in contact with the loop wire. One continuous piece of backer-rod will not be allowed.

After the loops are properly seated and tested, the slots shall be filled with a two-part self-curing, self-bonding epoxy or grout, as recommended by the manufacturer. Excess epoxy shall be removed to avoid unnecessary high spots, and level with the roadway surface.

Loop leads shall be pulled into cabinet without splices to match original installation when applicable.

All detector loops shall measure six feet by six feet.

Installation at an ATR count or classification site shall consist of one loop or one loop set (two loops) within a single lane. The loop sets shall be separated by 10 feet, plus or minus 1 inch, resulting in a distance of sixteen feet from the leading edge of the first loop in the direction of travel to the leading edge of the second loop.

Loop and loop leads shall be installed directly into the pavement, to pavement edge, pull box or cabinet. If loops are installed during asphalt paving, the loops shall be installed before the final lift is placed.

Loop lead wires from pavement edge to pull box shall be enclosed in ¾ inch PVC conduit or ¾ inch rubber hose to protect wire from abrasion. Loop lead-in pairs from pavement edge, to pull box, shall be symmetrically twisted 5 turns per 1 foot. Pull boxes or cabinet shall contain a minimum of 3 feet of loop lead wire for splicing. All loop and loop leads shall be clearly labeled in all pull boxes and cabinets. The Contractor shall be responsible for all trenching and digging from pavement edge to pull box.

All splices shall be made with approved waterproof pressure connector. All splices shall be capable of satisfactory operation under continuous submersion in water.

(c) *Piezo Installation*

The piezo shall be permanently installed by grouting into the roadway flush to 1/16 of an inch above the roadway surface by grouting into a concrete roadway or the final lift of asphalt.

Piezo sensors shall be installed in compliance with the manufacturer's recommendations.

At an ATR axle classification site, one 6 foot piezo sensor per lane shall be installed at the exact midpoint between the two loops and to the right or left side of the line, centered in the wheel path.

The saw cut shall be as straight as possible and shall not vary more than ½ inch when checked with a straightedge. The size of the saw cut shall be to the manufacturer's specifications and not vary more then 1/8 of an inch in width. The slot for the piezo lead wire shall be 3 inches deep and 3/8 of an inch wide. Only one piezo lead wire shall be placed in the saw slot.

Piezo lead shall be drilled when leaving the roadway surface at a 45 degree angle 8 inches from the pavement edge out through the side or bottom of the roadway, the drilled hole shall be no larger than ¾ of an inch. All holes shall be spaced a minimum of 3 inches from one another. No more than one piezo lead wire shall be placed in one drill hole.

Saw cuts shall be hydro-blasted with a mixture of water and air and then blown free of water and debris with compressed air, using a large capacity air compressor of at least 150 cubic feet per minute. The cuts shall be dry and cleaned with acetone prior to placement of the piezo.

The piezo shall not be installed if roadway surface temperature is not above the manufacturer's recommended minimum temperature, or cannot be maintained above this temperature for a minimum of two hours after installation. The piezo shall not be installed if roadway surface temperature is above the manufacturer's highest recommended temperature for grout installation.

The piezo lead wire shall be placed in the saw slot with a blunt non-metallic object. A ½ inch backer-rod shall be installed to insure the wire does not float to the surface during grouting. The backer-rod shall be installed in 4 to 6 inch pieces with 1 to 2 foot gaps in between, to insure the sealant will come in contact with the piezo lead wire. One continuous piece of backer-rod will not be allowed.

The sealant for the piezo lead wire shall be the same as that used for loops.

Piezo lead wire shall be pulled into the cabinet without splices, unless the length exceeds 300 feet.

Only one lead wire shall be placed in a saw slot.

Piezo lead wires from pavement edge to pull box shall be enclosed in ¾ inch PVC conduit or ¾ inch rubber hose, to protect wire from abrasion. Pull boxes or cabinet shall contain a minimum of three feet of piezo lead wire for splicing. Lead wire shall be clearly labeled as approved by the Engineer and the TDC.

All splices in piezo wiring shall be soldered and enclosed in a resin filled splice kit.

(d) Pull Boxes. All pull boxes on the shoulder of the roadway surface shall be raised to finished grade or level with the surrounding ground. If the shoulder has been raised to the point that the conduit is below the bottom of the pull box, then the conduit shall be raised. All wiring splices for existing wiring shall be a minimum of 12 inches in length above the conduit.

All existing pull boxes that are found to be damaged shall be replaced.

(e) *Water Valves.* A minimum of two feet of slack shall be provided on the loop and piezo wires that are contained in water valves.

No splices shall be allowed in water valves.

(f) *Pull Rope.* A 1/8 inch nylon pull rope shall be installed in all new conduits and all existing conduits where a wire or cable is added or an existing wire or cable is replaced.

(g) *Conduit*. The contractor shall seal all conduits with a sealing compound where a wire or cable is added or an existing wire or cable is replaced. The sealing compound shall be UL tested and approved for use. Sealing compound shall be a permanently soft, fibrous, non-staining sealer that can be easily applied and removed by hand at all working temperatures. Sealing compound shall be designed to seal out weather, moisture, dust rodents, and atmospheric conditions both indoors and outdoors. No foam sealant will be allowed.

(h) *Telephone Drop/Connection*. The contractor shall maintain the existing telephone drop/connection to the permanent ATR cabinet for connection to DTD.

REVISION OF SECTION 614
BUFFER TUBE FAN-OUT KIT

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

For this project, the Buffer Tube Fan-out Kit shall be furnished and installed on single mode fiber optic lateral cable ends in field communications cabinets.

MATERIALS

Buffer Tube Fan-Out Kits shall match the number of fiber strands in the lateral fiber optic cable. Buffer tube fan-out kits shall be compatible with the fiber optic cable being terminated and shall be color-coded to match the lateral fiber strand color. Fan out kit buffer tubes shall be 900 um. The buffer tube fan out kit fiber strand length shall be sufficient for routing and placement in the termination panel. All components of the fan-out kit shall be rated for outdoor use.

CONSTRUCTION REQUIREMENTS

The Contractor shall install fiber optic buffer tube fan-out kits on the lateral cable in each communications cabinet. The Contractor shall install fanned out cables on the ends of lateral fiber cable strands. Buffer tubes for lateral fiber strands shall be neatly coiled and secured within the field termination panels. Taping or leaving the buffer tubes unmanaged shall not be allowed.

REVISION OF SECTION 614
BREAKAWAY TAPERED ITS STEEL POLE

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

For this project, this work shall consist of furnishing and installing the steel tapered pole, breakaway transformer base, and fiber-optic disconnect, as described herein.

MATERIALS

An aluminum transformer base shall be provided which shall conform to breakaway requirements of the American Association of State Highway and Transportation Officials (AASHTO), 2013 Sixth Edition of the Standard Specification for the Supports for Highway Signs, Luminairies and Traffic Signals; and accepted for use by the Federal Highway Administration (FHWA). An aluminum access door and grounding provision with hardware shall be provided in the transformer base. The door opening shall be approximately 11 inches tall, 8.5 inches wide at the top, and 9 inches wide at the bottom. Connecting bolts, flat washers, bearing washers and hex nuts shall be provided with the base assembly. All structural fasteners shall be galvanized high strength carbon steel. All non-structural fasteners shall be galvanized or zinc-plated carbon steel or stainless steel. A satin finish shall be provided unless otherwise requested by the Engineer.

The fiber optic connection to the communications cabinet shall include a breakaway reusable connection system, within the transformer base, which is designed to disengage upon breakaway impact to the steel support pole. This breakaway connection shall be flood resistant, dust proof, and waterproof. Connection shall be immediately reusable after breakaway impact, without field repair or re-termination of the fiber optic cable.

Steel Pole shall conform to the following requirements:

(a) Fabricator

The fabricator shall be certified under Conventional Steel Building Structures (SBD) as set forth by the American Institute of Steel Construction (AISC) Quality Certified Fabricators Program. Proof of this certification shall be supplied with the submittal of poles to confirm that the fabricator has the personnel, organization, experience, procedures, knowledge, equipment, capability and commitment to fabricate quality steel pole structures.

(b) Welding

All welding shall be in accordance with Sections 1 through 8 of the American Welding Society (AWS) D1.1 *Structural Welding Code Steel*. Tackers and welders shall be qualified in accordance with the code. Tube longitudinal seam welds shall be free of cracks and excessive undercut, performed with automatic processes, and be visually inspected.

Longitudinal welds suspected to contain defects shall be magnetic particle inspected. All circumferential butt-welded pole splices shall be ultrasonically or radiographically inspected.

(c) Material Certifications

All materials and products shall be manufactured in the United States of America, and comply with American Society for Testing and Materials (ASTM) or AASHTO specifications. Mill certifications shall be supplied as proof of compliance with the specifications.

(d) Pole Shaft

The pole shaft should be one piece construction, and shall conform to ASTM A595 with a minimum yield strength of 55 kips per square inch or ASTM A572 with a minimum yield strength of 55 kips per square inch. The shaft shall have a constant linear taper of 0.14 inch per foot, and contain only one longitudinal seam weld. Circumferential welded tube butt splices and laminated tubes are not permitted. Longitudinal seam welds within 6 inches of complete penetration pole to base plate welds shall be complete penetration welds.

(e) Ground Lug

A ground lug shall be provided within the interior base of the pole for connection to a grounding system as specified in Revision of Section 614 – Grounding and Bonding. A bare copper ground wire shall be provided by the Contractor between the pole's ground lug and a ground rod adjacent to the pole's caisson to provide grounding. The ground wire shall be installed in a dedicated conduit (0.5 inch diameter, minimum) within the pole caisson provided by the Contractor. The Contractor shall bond the ground wire to the pole's ground lug and the ground rod in accordance with the Grounding and Bonding project special provision.

(f) Base Plates

At a minimum, base plates shall conform to ASTM A36 *Standard Specification for Carbon Structural Steel* or A572 Grade 50. Plates shall be integrally welded to the tubes with a telescopic welded joint or a full penetration butt weld with backup bar. Plates shall be hot dip galvanized per the requirements of the contract documents and finished in accordance with these specifications.

(g) Anchor Bolts

At a minimum, anchor bolts shall conform to the requirements of ASTM F1554 for Grade 55. The upper 12 inches of the bolts shall be hot dip galvanized per ASTM A153. Each anchor bolt shall be supplied with two hex nuts and two flat washers. The strength of the nuts shall equal or exceed the proof load of the bolts.

CONSTRUCTION REQUIREMENTS

All work shall conform to the specifications referenced herein and the current edition of NFPA 70, and shall conform to subsection 107.01.

Each Breakaway Tapered ITS Steel Pole shall be installed as designated herein. The Contractor shall furnish and install all incidentals necessary to provide a complete working system at each location.

REVISION OF SECTION 614
CLOSED CIRCUIT TELEVISION

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing a High Definition (HD) Internet Protocol (IP) Closed Circuit Television (CCTV) camera.

MATERIALS

CCTV camera shall include: The camera housing, pole mount adapter, Power over Ethernet (PoE) power supply, manufacturer supplied management software, Category 5e rated (CAT5e) cables, and all attachment hardware needed for a functionally complete installation.

(a) Camera

The camera shall have pan, tilt, and zoom functionality enclosed in a sealed, environmentally controlled dome housing designed to operate in 100 percent humidity at an operating temperature range of -58°F to 122°F. The camera housing shall carry both IP66 and National Electrical Manufacturers Association (NEMA) 4x ratings. The camera shall utilize a 100 megabits per second 802.3 Ethernet connection for native communications and be powered from an 802.3at compliant Power over Ethernet (PoE) supply. The camera shall be able to display multiple individually configurable video streams up to 30 frames per second in high definition resolutions from 1920 x 1080 pixels to 320 x 180 pixels at a 16:9 aspect ratio in H.264 and Motion JPEG (MJPEG) formats using unicast or multicast delivery. The camera shall include functionality for onscreen titling, image overlay, and remote capture of at least 256 preset views. It shall include electronic image stabilization, ability to reduce effects of rain and fog in picture, and include ability to run manufacturer or third party analytics designed for roadway applications with output to initiate internal user programed events or alarms to external systems using an open application programming interface (API) structure. An internal web interface shall be included for configuration with security functionality allowing a minimum of 20 user access levels with password protection. The camera shall be capable of implementing stream authentication for video security and the ability to modify view and control priority among configured users. Options for video storage shall be available via onboard Secure Digital (SD) memory slot or to network share. Camera status and diagnostics shall be available via Simple Network Management Protocol (SNMP) traps. The camera shall support:

(1) IPv4/v6
(2) Hypertext Transfer Protocol (HTTP)
(3) Hypertext Transfer Protocol Secure (HTTPS)
(4) Secure Socket Layer/Transport Layer Security (SSL/TLS)
(5) Quality of Service (QOS) Layer 3 Differentiated services (DiffServ)
(6) File Transfer Protocol (FTP)
(7) Simple Mail Transfer Protocol (SMTP)

(8) SNMP v1/2/3
(9) Universal Plug and Play (UPnP)
(10) Domain Name System (DNS)
(11) Dynamic Domain Name System (DDNS)
(12) Network Time Protocol (NTP)
(13) Real-time Transport Protocol (RTP)
(14) Real Time Streaming Protocol (RTSP)
(15) Transmission Control Protocol (TCP)
(16) User Datagram Protocol (UDP)
(17) Internet Group Management Protocol (IGMP)
(18) Real-time Transport Control Protocol (RTCP)
(19) Address Resolution Protocol (ARP)
(20) Socket Secure (SOCKS)

The camera shall be Open Network Video Interface Forum (ONVIF) compliant.

Technical specifications for the camera shall be as follows:

(1) The lens shall be f=4.44 to 142.6 mm, F1.6 to 4F14.41, autofocus; focus range of 35 mm (wide) to 800 mm (telephoto) to infinity, with 62.8 degrees to 2.23 degrees horizontal angle of view.
(2) Minimum illumination:
    (A) Color: 0.3 lux at 30 IRE F1.6
    (B) Black and White: 0.03 lux at 30 IRE F1.6
(3) Shutter speed shall be variable from 1/33,000 to 0.25 seconds at 60 hertz.
(4) The pan, tilt, and zoom functions shall provide 360 degrees of continuous pan rotation at 0.05 degrees per second to 450 degrees per second, a 220 degree tilt range allowing for 20 degree view above the horizon at 0.05 degrees per second to 450 degrees per second, and minimum 32 times optical and 12 times digital zoom.

(b) Manufacturer's Supplied Configuration and Management Software

Configuration software shall be included which gives the user access to discover and configure the camera using standard network protocols.

A centralized management software shall also be available to remotely discover and manage all available cameras across an Ethernet network for monitoring and configuration. The management software should be based on a server client architecture and shall include functionality to receive camera status, manage and apply blanket firmware updates to applicable devices, view/add/change user access accounts, and manage and apply device configuration templates using specific parameters saved by the user.

(c) Pole-Mount Adapter Arm and Bracket

The adapter shall have a minimum 33 pound load rating and have provisions that allow mounting directly to the weatherproof dome housing without modification to the housing. The adapter bracket shall have slots for a minimum of two straps or banding material for mounting to the poles

with diameters ranging from 3 inches to 6 inches. The bracket shall have cable strain relief in at least two locations on the reverse side, between the bracket and the pole.

(d) Cat5e Cable

Cable shall be an eight wire twisted pair cable constructed of 24 American Wire Gauge (AWG) stranded copper wires with minimum Cat5e rating. The outer jacket shall be ultraviolet (UV) resistant polyvinylchloride (PVC) insulation designed for outdoor use. Shielded cable shall be used when prescribed by the manufacturer, run through conduit and enclosed structures, and when needed for equipment or electrostatic grounding. Shielded cable shall be terminated with either conductive or non-conductive male 8P8C connectors. Where shielded cable is used as an equipment ground, conductive connectors shall be used on both ends of the cable. Where shielded cable is used as an electrostatic drain, the grounded side of the connection shall be terminated with a conductive connector and the ungrounded side shall be terminated with a non-conductive connector. Unshielded cable shall be used for interconnections within the same cabinet, or where grounding and electromagnetic interference is not present. Unshielded cable shall be terminated with non-conductive male 8P8C connectors on both ends. All Cat5e cables used for Ethernet data shall conform to the Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA) T-568B pin/pair assignments.

CONSTRUCTION REQUIREMENTS

The CCTV camera shall be installed in accordance with these specifications and in accordance with manufacturer's recommendations. The Contractor shall make arrangements required for a qualified manufacturer's representative to be on-site to ensure proper installation of the CCTV camera.

The weatherproof dome housing shall be attached to the pole mount adapter using the materials supplied from the manufacturer.

The camera shall be attached 1 foot below the top of the pole at an orientation to achieve the optimal view of both the main and crossroad traffic, or as directed by the Engineer. Three quarter inch type 201 stainless steel strap used in conjunction with type 201 stainless steel buckles shall be used to band the camera assembly and pole mount adapter to the pole.

The PoE midspan module shall be securely mounted in the communication cabinet as directed by the Engineer. The PoE shall be plugged into a grounded non-ground-fault circuit interrupter (GFCI) protected outlet. If available, an Uninterruptible Power Supply (UPS) protected outlet shall be used to power the power supply.

A shielded Cat5e cable with conductive RJ-45 terminations shall be run from the PoE supply to the camera providing a path to ground. A shielded Cat5e cable with a conductive RJ-45 termination on one end and non-conductive termination on the other shall be installed from the PoE supply to the field communication device with the conductive termination plugged into the PoE supply.

A maximum 1 inch hole shall be drilled in the mounting pole to allow passage of the Cat5e cable. The hole shall be free of burs and sharp edges prior to the installation of the cable. The cable shall be attached to the reverse side of the mounting bracket to ensure proper strain relief. The Ethernet cable shall run down the interior of the structure and exit through non-metallic flexible

conduit to the communication cabinet. The non-metallic flexible conduit shall be weather sealed on each end to eliminate exterior liquid entry. The Contractor shall provide a weather seal for the adapter bracket at the 1 inch hole at the top of the pole per the manufacturer's recommendations.

The Contractor shall ensure that the installation meets all minimum requirements set forth by the manufacturer in a manner to ensure all work will be covered by the manufacturer's warranty.

The Contractor shall configure the camera with an IP address as provided by the Engineer. The cameras shall be tested for full functionality and verification of access on the connected network. See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
CLOSED CIRCUIT TELEVISION POLE WITH LOWERING DEVICE

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

For this project, this work shall consist of furnishing and installing the Closed-Circuit Television (CCTV) Internet Protocol (IP) based camera pole(s) and lowering system(s) as described herein.

MATERIALS

Subsection 614.02 shall include the following:

The camera lowering system shall be designed to support and lower an Ethernet (IP-based) CCTV camera, lens, housing, Pan-Tilt-Zoom (PTZ) mechanism, cabling, connectors and other supporting field components without damage or causing degradation of camera operations. The camera lowering system device and the pole are interdependent; and shall be considered as single systems. The lowering system shall consist of a steel pole, suspension contact unit, divided support arm, and a pole adapter for attachment to a pole top tenon, pole top junction box, conduit mount adapter and camera connection box. The divided support arm and receiver brackets shall be designed to self-align the contact unit with the pole center line during installation and ensure the contact unit cannot twist under high wind conditions. Round support arms will not be accepted. The camera lowering system shall withstand wind forces of 110 mph with a 30 percent gust factor using a 1.65 safety factor. The lowering system manufacturer shall furnish independent laboratory testing documents certifying adherence to the stated wind force criteria utilizing, as a minimum Effective Projected Area (EPA), the actual EPA or an EPA greater than that of the camera system to be attached. The camera lowering system to be furnished shall be the product of manufacturers with a minimum of five years of experience in the successful manufacturing of camera lowering systems. The lowering system provider shall be able to identify a minimum of three previous projects where the proposed system has been installed successfully for over a one-year period of time each.

The lowering system manufacturer shall furnish an authorized factory representative to support the Contractor with the assembly and testing of the first lowering system onto the pole assembly. The manufacturer shall furnish documentation to CDOT certifying that the Contractor has been instructed on the installation, operation and safety features of the lowering system for this specific project. The Contractor shall be responsible for providing applicable “on site" operational instructions for CDOT maintenance personnel.

(a) Suspension Contact Unit.

The suspension contact unit shall have a load capacity 600 pounds with a 4 to 1 safety factor. There shall be a locking mechanism between the fixed and moveable components of the lowering system. The movable assembly shall have a minimum of two latches. This latching mechanism shall securely hold the device and its mounted equipment. The latching mechanism shall operate by alternately raising and lowering the assembly using the winch and lowering cable. When

latched, all weight shall be removed from the lowering cable. The fixed unit shall have a heavy duty cast tracking guide and means to allow latching in the same position each time.

The contact unit housing shall be weatherproof with a gasket provided to seal the interior from dust and moisture. The entire unit shall have a minimum temperature rating of -40ºF to +190ºF.

The prefabricated components of the lift unit support system shall be designed to preclude the lifting cable from contacting the data, power or video cabling. The lowering system manufacturer shall provide a conduit mount adapter for housing the lowering cable. This adapter shall have an interface to allow the connection of a contractor provided 1.25 inch PVC conduit and be located just below the cable stop block at the back of the lowering system. The Contractor shall supply internal conduit in the pole as directed by the lowering system manufacturer. The only cable permitted to move within the pole or lowering system during lowering or lifting shall be the stainless steel lowering cable. All other cables must remain stable and secure during lowering and lifting operations. Lowering systems for two camera installations shall be configured to not interfere with each other at any time during lowering operations.

The lowering system must be specifically equipped with electrical contacts connectors designed for extreme environmental outdoor use with a CCTV IP camera connected via an outdoor-rated CAT5e Shielded Twisted Pair (STP) cable utilizing Power over Ethernet (PoE).

The female and male socket contact halves of the connector block shall be made of a Underwriters Laboratories (UL) 94 *Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*, V-0 rated thermosetting synthetic rubber. The female barrel contacts and the male pin contacts shall be permanently and integrally encased in this rubber material to ensure protection from moisture and the environment.

All current carrying male pin and female socket/barrel contacts shall be gold-plated per ASTM B488 *Standard Specification for Electrodeposited Coatings of Gold for Engineering Uses* over nickel-plated CA 360 in accordance with SAE International AMSQQN290C *Nickel Plating (Electrodeposited)*. Male contact sizing shall be a minimum of 0.09 inches while the female contacts shall be at least 0.09 inches (inside diameter) at the contact area. All contact shall be a minimum of 0.09 inches in diameter at the contact area. Each individual female barrel contact shall have a nickel-plated CA 360 sleeve that prevents foreign matter from entering the contact area as well as preclude the possibility of the leaves of the female contact from opening beyond allowable limits and ensure a snug fit around the respective male pins. There shall be one contact that is positioned in a manner which will allow it to make first and break last providing optimum grounding performance.

Each Ethernet (IP-based) male-female connector shall include a total of 13 specifically designed contacts. Eight contacts soldered to outdoor-rated CAT5e STP wire end terminated with a shielded RJ-45 male connector and five contacts soldered to #18/1 UL lead wire – bare and numbered 1-5, which may be used for additional camera requirements including but not limited to power, alarms or grounds. All soldering shall be per IPC J STD-001E *Requirements for Soldered Electrical and Electronic Assemblies*. Each individual contact shall be rated for up to 600 volts and 7 amps, but de-rated according to the wire used in the application. For optimum weatherproofing, each male shall be self-wiping with a shoulder at the base of each male contact so that it will recess into the female block, thereby giving a rain-tight seal to each individual contact when mated. Furthermore, the wire leads from both the male and female rubber contact blocks

shall be permanently and integrally molded in the synthetic rubber body. The facility manufacturing the electrical contact connector must comply with ISO 9001.

(b) Lowering Tool

The camera lowering system shall be operated by use of a portable lowering tool. The tool shall consist of a lightweight metal frame and winch assembly with factory spooled stainless steel aircraft cable, a quick release cable connector, an adjustable safety clutch and a variable speed industrial duty electric drill motor. This tool shall be compatible with accessing the support cable through the hand hole of the pole. The lowering tool shall have the capability to be securely attached to the pole with one single bolt. The tool must support itself and the load during lowering and lifting operations. The winch assembly shall include an automatic braking system that provides a means to prevent freewheeling when loaded. One lowering tool per project shall be delivered to the Project Engineer upon project completion. The lowering tool shall have a reduction gear to reduce the manual effort required to operate the lifting handle to raise and lower a capacity load. The lowering tool shall be provided with an adapter for operating the lowering system by a portable drill using a clutch mechanism. The lowering tool shall be equipped with a positive braking mechanism to secure the cable reel during lifting and lowering operations and prevent freewheeling. The manufacturer shall provide a variable speed, heavy-duty reversible drill motor, clutch and one lowering tool for every five camera lowering system poles provided as part of this Project. The lowering tool shall be made of durable and corrosion resistant materials, powder coated steel, galvanized steel, heavy duty aluminum or otherwise protected from the environment by industry-accepted coatings to withstand exposure to a corrosive environment.

(c) Camera Junction Box

The camera junction box shall be used to provide both a mounting location for the CCTV camera as well as an interface compartment for wire leads from the lowering system to the CCTV camera or applicable surge suppression module. The camera junction box shall consist of a two piece clamshell design with one removable hinge side and one latch side with a single toggle bolt to facilitate easy access. The general shape of the box shall be cylindrical to minimize the effective projected area. The camera junction box shall be cast aluminum with stabilizing weights on the outside of the box to increase room on the interior. The camera junction box shall be capable of accommodating up to 40 pounds of stabilizing weights. The bottom of the camera junction box shall be drilled and tapped with a 1.5 inch National Pipe Thread (NPT) female thread to accept industry standard dome housings and must include the capability to be modified to accept a wide variety of other camera mountings. The camera junction box shall be gasketed to prevent water intrusion. The bottom of the camera junction box shall incorporate a screened and vented hole to allow airflow and reduce internal condensation.

(d) Miscellaneous

All pulleys for the camera lowering system and portable lowering tool shall have sealed, self-lubricated bearings, oil tight bronze bearings, or sintered oil impregnated bronze bushings. The lowering cable shall be a minimum 0.125 inch diameter stainless steel aircraft cable with a minimum breaking strength of 1,740.

All electrical and video Ethernet connections between the fixed and lowered portion of the contact block shall be protected from exposure to the weather by both a gasket on the bottom side of the bell housing enclosure as well as the "O" ring shoulders at the base of each male contact pin to prevent degradation of the power/signal contacts.

The interface and locking components shall be made of stainless steel or aluminum. All external components of the lowering system shall be made of corrosion resistant materials, powder coated, galvanized, or otherwise protected from the environment by industry-accepted coatings to withstand exposure to a corrosive environment.

In the event any CCTV is not properly weight balanced and plumb, the CCTV camera manufacturer shall provide weights or counterweights as necessary to assure that the alignment of pins and connectors are proper for the camera support to be raised into position without binding.

The CCTV camera manufacturer or Contractor shall provide all applicable power and signal connectors for attachment to the bare leads and shielded RJ-45 male connectors in the pole top and camera junction boxes.

The CCTV camera manufacturer or Contractor shall provide appropriate length of outdoor-rated CAT5e STP (stranded) cable (PoE/signal) in one continuous run from the respective equipment cabinet to the pole top junction box of each lowering system pole.

The caisson foundation shall be in accordance with the CDOT Caisson Foundation Detail for CCTV Pole with Lowering Device.

(e) Camera Lowering System Pole.

(1) **Dimensions and Pipe Wall Thickness:** Steel pole dimensions, wall thickness, and details shall be in accordance with the most recent CDOT Standard Drawing "*CCTV Pole with Lowering Device"*.

(2) **Fabricator:** The fabricator shall be certified under Conventional Steel Building Structures (SBD) as set forth by the American Institute of Steel Construction (AISC) Quality Certified Fabricators Program. Proof of this certification shall be supplied with its pole submittal to ensure that the fabricator has the personnel, organization, experience, procedures, knowledge, equipment, capability and commitment to fabricate quality steel pole structures.

(3) **Welding:** All welding shall be in accordance with Sections 1 through 8 of the American Welding Society (AWS) D1.1 Structural Welding Code for Steel. Tackers and welders shall be qualified in accordance with the code. Tube longitudinal seam welds shall be free of cracks and excessive undercut, performed with automatic processes, and be visually inspected. Longitudinal welds suspected to contain defects shall be magnetic particle inspected. All circumferential butt-welded pole splices shall be ultrasonically or radiographically inspected.

(4) **Material Certifications:** All materials and products shall be manufactured in the United States of America, and comply with ASTM or AASHTO specifications. Mill certifications shall be supplied as proof of compliance with the specifications.

(5) **Pole Shaft:** The pole shaft should be one piece construction up to 50 feet in length, and shall conform to ASTM A595 *Standard Specification for Steel Tubes, Low Carbon*

or High-Strength Low-Alloy, Tapered for Structural Use Grade A with a minimum yield strength of 55 kips per square inch or ASTM A572 *Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel* with a minimum yield strength of 55 kips per square inch. Poles greater than 50 feet in length shall be of multi-piece construction. All structures with pole shaft diameters of 26 inches or less shall be round; pole shaft diameters greater than 26 inches may be round or multi-sided. The shaft shall have a constant linear taper not exceeding 0.14 inch per foot, and contain only one longitudinal seam weld. Circumferential welded tube butt splices and laminated tubes are not permitted. Longitudinal seam welds within 6 inches of complete penetration pole to base plate welds shall be complete penetration welds.

(6) **Hand Holes for Winch Operation:** A single hand hole may be provided in lieu of the dual hand holds detailed. If a single hand hole is detailed, the hand hole opening shall be designed to meet AASHTO fatigue requirements in accordance with the latest interim revisions to the code, and reinforced with a minimum 2 inch wide hot rolled steel rim. The nominal outside dimension of a single hand hole shall be 6 inches by 27 inches. The single hand hole shall have a tapped hole for mounting the portable winch thereto and include a cover. Unless otherwise noted, the bottom lip of the single hand hole shall be located on the shaft between 30 inches to 33 inches from the baseplate.

(7) **Pole Top Tenon:** The pole shall have a custom plate mounted tenon as detailed in the most recent CDOT Standard Drawing "*CCTV Pole with Lowering Device"*.

(8) **Cable Supports/Electrical Cable Guides and Parking Stand (Eyebolts):** Cable supports, Electrical Cable Guides and Parking Stands shall be as detailed in the most recent CDOT Standard Drawing *"CCTV Pole with Lowering Device"*.

(9) **Ground Lug:** A ground lug shall be provided within the interior base of the pole for connection to a grounding system conforming to the requirements of Revision of Section 614 – Grounding and Bonding. A bare copper ground wire shall be provided by the Contractor between the pole's ground lug and a ground rod adjacent to the pole's caisson to provide grounding. The ground wire shall be installed in a dedicated conduit (0.5 inch diameter, minimum) within the pole caisson as provided by the Contractor. The Contractor shall bond the ground wire to the pole's ground lug and the ground rod. The Contractor shall furnish and install a copper coated steel ground rod (0.625 inch diameter and 8 feet long, minimum) and bond the ground rod to the pole's ground lug. The cabinet ground busbar and electrical disconnect (if applicable) shall be bonded to the pole's ground lug through the use of ground wire. The size of the ground wire, bonding methods, and ground rod installation, material and size shall be in conformance with Article 250 of the current edition of National Fire Protection Association (NFPA) 70 National Electric Code (NEC), unless otherwise specified by the Engineer.

(10) **Base Plates:** At a minimum, base plates shall conform to ASTM A36 *Standard Specification for Carbon Structural Steel* or A572 Grade 50. Plates shall be integrally welded to the tubes with a telescopic welded joint or a full penetration butt weld with backup bar. Plates shall be hot dip galvanized per the requirements of the contract documents.

(11) **Anchor Bolts:** At a minimum, anchor bolts shall conform to the requirements of

ASTM F1554 *Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength* Grade 55. The upper 12 inches of the bolts shall be hot dip galvanized per ASTM A153 *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*. Each anchor bolt shall be supplied with two hex nuts and two flat washers. The strength of the nuts shall equal or exceed the proof load of the bolts.

CONSTRUCTION REQUIREMENTS

All work shall conform to the specifications referenced herein and the current edition of NFPA 70, and shall comply with applicable regulations as specified in subsection 107.01 of the CDOT Standard Specifications for Road and Bridge Construction.

Each CCTV Pole with Lowering Device shall be installed as described herein. The Contractor shall furnish and install all incidentals necessary to provide a complete working system at each location.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
COARSE WAVELENGTH DIVISION MULTIPLEXING MODULE

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

Coarse Wavelength Division Multiplexing (CWDM) Module for this project shall be rack mounted and support 10 wavelengths from 1430nm to 1610nm with LC/APC Port Bulkheads, Test In Port, Test Out Port and Pass Port installed in regeneration node building or CTMC equipment racks or cabinets. The unit shall have the capabilities of passively multiplexing and de-multiplexing multiple wavelengths to and from field Ciena 3930 Ethernet switches and communications node building Ciena Ethernet Switch small form-factor pluggable optic modules.

The 10-channel CWDM modules shall be supplied with the ability of connecting a Spectrum Analyzer to the test ports to test both the incoming and outgoing wavelengths without the need of disconnecting active patch cables transmitting or receiving data.

MATERIALS

Each 10-channel CWDM module shall have twelve (12) transmit / receive ports. Ten of the 12 ports shall be for individual wavelength matching the Ethernet switch CWDM, SFP optic modules.

The bulkhead connector for each port on the CWDM module shall be of the duplex LC/APC type; simplex LC/APC type bulkhead connector ports shall not be allowed.

The 10-channel CWDM module shall have the ability of multiplexing and de-multiplexing the following wavelengths: 1430nm, 1450nm, 1470nm, 1490nm, 1510nm, 1530nm, 1550nm, 1570nm, 1590nm and 1610nm.

The 10-channel CWDM modules shall also include a chassis capable of mounting in a 19 inch communications equipment rack or cabinet. The chassis shall have an integrated cable management tray on the front side to house the optical patch cables installed from the CWDM multiplexing module ports to the Ethernet switch optic modules.

CONSTRUCTION REQUIREMENTS

The 10-channel CWDM multiplexing modules and chassis shall be installed in 19 inch equipment racks or cabinets in regeneration node buildings or the CTMC. The 10-channel CWDM multiplexing modules and chassis shall be installed adjacent to its corresponding Ciena 5150 Carrier Ethernet SAS switch. Where slots are available in existing chassis, the Contractor may utilize these slots for CWDM modules, pending approval by the Engineer.

Single mode, bend insensitive, pre-connectorized duplex patch cable with a polyurethane jacket shall be installed from the 10-channel CWDM module to the backbone termination patch panel for transmitting and receiving communications to the field Ethernet switches. Connectors for the patch cable shall be LC on the 10-channel CWDM module end and LC on the termination patch panel end.

Single mode, bend insensitive, pre-connectorized duplex patch cables with a polyurethane jacket shall be installed from each 10-channel CWDM module wavelength Tx/Rx port to the matching CWDM SFP optic module on its corresponding Ciena 5150 Carrier Ethernet SAS switch. A duplex patch cable shall be installed for each wavelength. Connectors for the patch cables shall be LC on the10-channel CWDM module end and LC on the Ethernet switch SFP optic module end.

In communication node buildings, the patch cables shall be of sufficient length to span from the termination patch panel to the 10-channel CWDM module and from the 10-channel CWDM module to the Ciena 5150 Ethernet switch with a maximum of four (4) feet of slack for each cable. They shall be installed in a manner which will not interfere with equipment in the equipment racks and will include cable management so as not to interfere with future maintenance within the rack.

If for any reason the 10-channel CWDM module is defective or is damaged at the time of installation by the Contractor, the item shall be removed and replaced at no additional cost to the project. Modules shall also be replaced if any failures occur due to manufacturer's defect, at no additional cost to the project, prior to the final network acceptance.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
COARSE WAVELENGTH DIVISION MULTIPLEXING SFP

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

For this project, the Coarse Wavelength Division Multiplexing SFP shall be a single wavelength CWDM SFP optic module for installation in a Ciena 3930/3931 Carrier Ethernet SDS. There shall also be a matching CWDM SFP optic module installed at the corresponding Ciena 5150 Carrier Ethernet SAS. All CWDM SFP optic modules shall be provided from a manufacturer recommended by Ciena.

MATERIALS

The Contractor shall furnish and install the CWDM SFP optic modules in the wavelengths as shown in the item table below. This table describes optic modules for installation in Ciena 3930/3931 Carrier Ethernet SDS Ethernet switches and Ciena 5150 Carrier Ethernet SAS switches. The Contractor shall be responsible for providing CWDM SFP optic modules for the corresponding Ciena 5150 Carrier Ethernet SAS switches utilized on this project.

Item Table – CWDM SFP Optic Modules for Ciena 3930 Carrier Ethernet SDS switches and Ciena 5150 Carrier Ethernet SAS switches.

ITEM DESCRIPTION	ITEM NUMBER
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1430 NM, EXT. TEMP	XCVR-A80D43
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1450 NM, EXT. TEMP	XCVR-A80D45
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1470 NM, EXT. TEMP	XCVR-A80D47
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1490 NM, EXT. TEMP	XCVR-A80D49
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1510 NM, EXT. TEMP	XCVR-A80D51
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1530 NM, EXT. TEMP	XCVR-A80D53
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1550 NM, EXT. TEMP	XCVR-A80D55
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1570 NM, EXT. TEMP	XCVR-A80D57
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1590 NM, EXT. TEMP	XCVR-A80D59
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1610 NM, EXT. TEMP	XCVR-A80D61

If for any reason the CWDM SFP optic modules are defective or are damaged at the time of installation by either the Contractor or by Ciena, the optic module shall be removed and replaced at no additional cost to the project. CWDM SFP optic modules shall also be replaced if any failures occur due to manufacturer's defect, at no additional cost to the project prior to the final network acceptance.

CenturyLink is the Ciena Corporation qualified equipment supplier for the State of Colorado, Colorado Department of Transportation, Intelligent Transportation Systems for networking equipment and associated network materials.

For project equipment estimate quotations and purchasing, Contractors shall contact the following distributer representative:

Project equipment, equipment estimates, and purchasing distributer representative:

Keith A. Glose

Premier Account Manager

CenturyLink Government

930 15th Street, 4th Floor, Denver, Colorado 80202

Telephone: 303-992-5567 Fax: 720-578-2694

E-Mail: keith.glose@centurylink.com

Neither CenturyLink nor Ciena Corporation will be involved in the design of the project corridor network. The Contractor shall contact the CenturyLink representative for equipment quotations and purchasing purposes only. The Contractor shall not contact or rely on either CenturyLink or Ciena for network design related questions.

When requesting quotations, the Contractor shall submit to CenturyLink a complete package including the following items:

- A complete list of required equipment for purchase including materials and quantities based on the individual project specifications to achieve a complete item(s) installation.
- A PDF copy of all project specifications pertaining to the material being ordered.
- A PDF copy of all networking project plan sheets.

It is the Contractor's responsibility to provide the distributer's representative all information required pertaining to the complete network design. During the project, CenturyLink or Ciena Corporation is not responsible for any type of network design aide. All questions pertaining to the design shall be through the Project Engineer for help or clarification.

CONSTRUCTION REQUIREMENTS

For Ciena 3930/3931 Carrier Ethernet SDS switch installations, a CWDM SFP optic module(s) shall be installed in each switch for CWDM data communications. A matching CWDM SFP optic module shall be installed at its corresponding Ciena 5150 Carrier Ethernet SAS switch.

The Contractor shall ensure that the wavelengths of the CWDM SFP optic modules installed in the Ciena 3930/3931 Carrier Ethernet SDS Ethernet switches match those installed in its corresponding Ciena 5150 Carrier Ethernet SAS switch to ensure proper data communications.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
COMMUNICATIONS CABINET

Section 614 of the Standard specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing ground mounted communications cabinets.

The Communications Cabinet (for Tolling) shall be a Type M Stretch Cabinet furnished for designated tolling field device sites to house and protect tolling equipment, communications equipment and power connections. The tolling equipment will be provided by others.

The Communications Cabinet (Type 332) shall be a Type 332 cabinet and furnished for designated locations to house and protect Toll Point Uninterruptible Power Supplies (UPS) and power connections.

The Communications Cabinet (Type 332D) shall be a Type 332D cabinet and furnished for VTMS and ITS field device sites that have UPS to house and protect field equipment, communications equipment, UPS and power connections.

MATERIALS

Subsection 614.02 shall include the following:

Communications Cabinets: The nominal dimensions shall be as shown in Table 1 below. Some variance from these dimensions may be accepted at the Engineer's discretion.

TABLE 1 - Communications Cabinet Types

Cabinet Type	Nominal Dimensions
Communications Cabinet (for Tolling)	68" (H) × 31" (W) × 19" (D)
Communications Cabinet (Type 332)	67" (H) × 24" (W) × 30" (D)
Communications Cabinet (Type 332D)	67" (H) × 49" (W) × 30" (D)

The following items apply to all ground mounted communications cabinets:

Communications cabinets shall be UL 508A *Industrial Control Panels* listed and conform to a NEMA Type 3R rating. Communications cabinets shall be H-32 aluminum conforming to the requirements of ASTM B209 *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate*.

All bolts, clamps, fasteners, hinges, latches, nuts and screws shall be stainless steel, unless an alternative corrosion proof material is approved in writing by the Department.

A cabinet grounding stud shall be provided in the vicinity of the cabinet ground bus bar.

All fabricated materials and added components must be free from burrs and sharp edges. Exterior seams of the cabinet shall be continuously welded with edges ground smooth to a 0.03 inch radius. All welding shall be done with gas tungsten arc welds that comply with AWS B2.1-22-015 *Standard Welding Procedure Specification for Gas Tungsten Arc Welding of*

Aluminum and C5.6 *Recommended Practices for Gas Metal Arc Welding*. All welds shall be neatly formed and free of blisters, blowholes, cracks and other irregularities. All bolts, clamps, fasteners, hinges, latches, nuts and screws shall be stainless steel, unless an alternative corrosion proof material is approved in writing by the Department.

The cabinet door openings shall be designed to prevent dust and moisture intrusion in conformance to NEMA 3R requirements. All flange joints shall be welded or continuously formed. The doors shall have an adequately sized, oil-resistant gasket that provides a uniform seal with the door frame surface in conformance with NEMA 3R requirements and shall be permanently bonded to the door. The door shall utilize a continuous stainless steel hinge that allows for door removal from the hinge side. Hinges shall be mounted such that the cabinet door opens out to the left, unless otherwise specified by the Department.

Hinges shall be mounted with appropriately sized stainless steel hardware. The door shall be equipped with a hasp and staple for padlocking and Corbin #2 key lock be utilized in place of the hasp and staple if the NEMA 3R rating can be maintained. A document holder constructed of high-impact thermoplastic shall be provided for each communications cabinet and permanently mounted to the lower portion of the inside door. The Contractor shall insert a copy of the communications cabinet Bill of Materials (BOM), individual communications cabinet component specification sheets and an as built electrical/low-voltage wiring diagram of the communications cabinet in the document holder.

Warranty: The communications cabinet manufacturer shall affix a permanent label on the inside of the door that identifies the cabinet type, date of manufacture, warranty expiration date and manufacturer's name. The warranty expiration date shall be expressed in the (mm/dd/yyyy) format. The warranty shall cover all communication cabinet materials and workmanship for two (2) years after delivery of each communication cabinet.

DIN Rail: A DIN rail shall be provided with each cabinet.

Internal Cabinet Lighting: Provide a minimum of two light-emitting diode (LED) light strips per door opening to provide illumination for the entire cabinet interior. Each door opening shall also be equipped with a door switch to activate the cabinet lighting. LED light strips and door switches shall be mounted such that they do not interfere with use of rack space or other devices in the cabinet and shall be easily removable for replacement.

Ventilation: Provide independently wired, 100 CFM exhaust fans near the top of the cabinet that are controlled by independent adjustable thermostats. Provide filtered air intake ports with removable and replaceable filter on the bottom third of each access door.

Grounding Bus Bar: Equipment ground bus bars shall be provided for each Communication Cabinet. Bus bars shall be UL listed and be fabricated from solid, 110 alloy copper. Each bus bar shall accommodate a minimum of seven (7) lug positions. The equipment grounding bus bar shall provide an additional 25% lug position capacity over the amount of terminations utilized for the various Communication Cabinet applications. Multiple bus bars may be used within each Communication Cabinet, if the interior dimensions of the cabinet do not allow for the use of a larger bus bar. Each bus bar shall include insulators, stand-off brackets, snap on covers, and stainless steel mounting hardware.

Foundation: Each Communications Cabinet shall include a polymer concrete or poured concrete pad that extends at least 2'-6" beyond the cabinet base on each cabinet door side

and at least 6" beyond the cabinet base on the other two sides. The cabinet base shall be sealed around the conduits.

The following items are specific to the Communications Cabinet (For Tolling) only:

Back Panel: Cabinet back panel shall be constructed of 0.10 inch Type 5052-H32 aluminum alloy unless otherwise specified by the Department. The back panel dimensions shall be approximately 25" W x 54" H, and shall be offset from the back of the cabinet with enough air space to allow for mounting screws to be used without penetrating the external cabinet shell. Panel should mount on fixed bolts inside the cabinet. If not included, E-470 will procure side planes to be incorporated allowing for all ITS equipment to be accommodated. All associated mounting hardware for the back panel shall be included with each communications cabinet and be rated for use in NEMA 3R cabinets.

Circuit Breakers: Two 20 amp breakers and one 40 amp main breaker shall be provided with the cabinet. The breakers shall be DIN rail mountable.

Cabinet Riser: A minimum 12" high riser is required for the tolling point cabinets. The riser shall be constructed from the same material as the cabinet and shall include a connection mechanism to which the cabinet can be attached. The bottom of the riser shall be solidly connected to the pad.

The following items are specific to the Communications Cabinet (Type 332) only:

Cabinet Rack: Full-height standard Electronics Industry Alliance (EIA) 19-inch rack with a minimum of one (1) pullout drawer.

Insulation: Provide R-4 insulation on interior, sides, top and all doors.

Load Center: Each load center shall be readily accessible on the interior of the cabinet close to the door. The load center shall provide a main and a minimum of three (3) branch circuits. The neutral and ground bars shall be tied together in the load center.

Receptacles: Provide a minimum of one (1) 15-amp NEMA 15-R 120VAC duplex GFCI receptacle labeled "Convenience Outlet" and one (1) 15-amp NEMA 15-R 120VAC duplex receptacle labeled "ITS Equipment".

The following items are specific to the Communications Cabinet (Type 332D) only:

Cabinet Rack: Two (2) full-height standard Electronics Industry Alliance (EIA) 19-inch racks with a minimum of one (1) pullout drawer.

Insulation: Provide R-4 insulation on interior, sides, top and all doors.

Load Center: Each load center shall be readily accessible on the interior of the cabinet close to the door. The load center shall provide a main breaker and a minimum of four (4) branch circuits. The load center shall be Underwriters' Laboratories (UL) listed and provide a short circuit rating of 22,000 amps for main and 10,000 amps branch circuits.

Receptacles: Provide a minimum of one (1) 15-amp NEMA 15-R 120VAC duplex GFCI receptacle labeled "Convenience Outlet" and one (1) 15-amp NEMA 15-R 120VAC duplex receptacle labeled "ITS Equipment".

CONSTRUCTION REQUIREMENTS

Each communications cabinet (for tolling) shall have tapped pads to provide for the mounting of a back panel as specified herein.

Conduit accesses into the cabinet for electrical wiring, specific field device low-voltage control cabling, waveguides and fiber optic cabling, shall be plugged with a manual plug (no foam sealant is allowed).

After installation, the top of the cabinet should be approximately 5 feet above the prevailing ground line.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
COMMUNICATIONS CABINET (TYPE 2)

Section 614 of the Standard specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing communications cabinets at Intelligent Transportation System (ITS) field device locations without Uninterruptible Power Supplies (UPS) to house and protect electrical power components, DIN rails, field equipment, serial servers, communications telemetry equipment, and fiber optic termination panels. Communication Cabinet (Type 2) shall be a Caltrans 336S and shall be pole-mounted at all CCTV lowering device locations and sign structure. Ground-mounted cabinets shall include a raised polymer concrete or poured concrete pad and base.

MATERIALS

Communications Cabinets: The nominal dimensions shall be as shown in Table 1 below. Some variance from these dimensions will be accepted, at the Engineer's discretion.

TABLE 1 - Communications Cabinet Types

Communications Cabinet	Dimensions	Maximum Weight (w/o back panel)
Type 2	46 inches (H) × 24 inches (W) × 22 inches (D)	N / A

Communications cabinets shall be UL 508A Industrial Control Panels listed and conform to a NEMA Type 3R rating. Communications cabinets shall be H-32 aluminum conforming to the requirements of ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

All bolts, clamps, fasteners, hinges, latches, nuts and screws shall be stainless steel, unless an alternative corrosion proof material is approved in writing by the Department.

A cabinet grounding stud shall be provided in the vicinity of the ground bus mounted on the back panel as shown on the Plans.

All fabricated materials and added components must be free from burrs and sharp edges. Exterior seams of the cabinet shall be continuously welded with edges ground smooth to a 0.03 inch radius. All welding shall be done with gas tungsten arc welds that comply with AWS B2.1-22-015 Standard Welding Procedure Specification for Gas Tungsten Arc Welding of Aluminum and C5.6 Recommended Practices for Gas Metal Arc Welding. All welds shall be neatly formed and free of blisters, blowholes, cracks and other irregularities. All bolts, clamps, fasteners, hinges, latches, nuts and screws shall be stainless steel, unless an alternative corrosion proof material is approved in writing by the Department.

The cabinet door openings shall be designed to prevent dust and moisture intrusion in conformance to NEMA 3R requirements. All flange joints shall be welded or continuously formed. The doors shall have an adequately sized, oil-resistant gasket that provides a uniform seal with the door frame surface in conformance with NEMA 3X requirements and shall be permanently

bonded to the door. The door shall utilize a continuous stainless steel hinge that allow for door removal from the hinge side. Hinges shall be mounted such that the cabinet door opens out to the left, unless otherwise specified by the Department. Hinges shall be mounted with appropriately sized stainless steel hardware.

The door shall be equipped with a hasp and staple for padlocking and Corbin #2 key lock be utilized in place of the hasp and staple if the NEMA 3R rating can be maintained. A document holder constructed of high-impact thermoplastic shall be provided for each communications cabinet and permanently mounted to the lower portion of the inside door. The Contractor shall insert a copy of the communications cabinet Bill of Materials (BOM), individual communications cabinet component specification sheets and an as- built electrical/low-voltage wiring diagram of the communications cabinet in the document holder.

Warranty: The communications cabinet manufacturer shall affix a permanent label on the inside of the door that identifies the cabinet type, date of manufacture, warranty expiration date and manufacturer's name. The warranty expiration date shall be expressed in the (mm/dd/yyyy) format. The warranty shall cover all communication cabinet materials and workmanship, including pole mounting kits, for two (2) years after delivery of each communication cabinet.

Internal Cabinet Lighting: Provide a minimum of two light-emitting diode (LED) light strips per door opening to provide illumination for the entire cabinet interior. Each door opening shall also be equipped with a door switch to activate the cabinet lighting. LED light strips and door switches shall be mounted such that they do not interfere with use of rack space or other devices in the cabinet and shall be easily removable for replacement.

Insulation: Provide R-4 insulation on interior, sides, top and all doors.

Ventilation: Provide independently wired, 100 CFM exhaust fans near the top of the cabinet that are controlled by independent adjustable thermostats. Provide filtered air intake ports with removable and replaceable filter on the bottom third of each access door.

Grounding Bus Bar: Equipment ground bus bars shall be provided for each Communication Cabinet. Bus bars shall be UL listed and be fabricated from solid, 110 alloy copper. Each bus bar shall accommodate a minimum of seven (7) lug positions. The equipment grounding bus bar shall provide an additional 25% lug position capacity over the amount of terminations utilized for the various Communication Cabinet applications. Multiple bus bars may be used within each Communication Cabinet, if the interior dimensions of the cabinet do not allow for the use of a larger bus bar. Each bus bar shall include insulators, stand-off brackets, snap on covers, and stainless steel mounting hardware.

Cabinet Layout: Each Communications Cabinet shall be physically divided into two (2) sides by a sliding aluminum backplane. The front side will house all associated ITS electronics, communication device hardware and a duplex GFCI convenience outlet. The back side will house the power and fiber resources, such as: 120V main power feeding the cabinet, the Clary power conditioner, 6-outlet power strip, equipment power supplies, the fiber termination panel and slack fiber.

Back Plane (Front and Back Sides): The back plane shall be constructed of 0.10 inch Type 5052-H32 aluminum alloy, unless otherwise specified by the Department. A two-sided back plane and associated mounting hardware shall be included with each communications cabinet and be rated for use in NEMA 3R cabinets. The backplane shall be approximately 1-inch less on each

side than the inside dimensions. The back plane shall have at least 1inch of air space between the two sides to allow for mounting screws to be used from either side without protrusion through the opposing face. The backplane shall be mounted within the communications cabinet with a minimum of four screws on an adjustable sliding channel.

Outlet Box (Front and Back Sides): The communications cabinet shall contain a 4 inch square junction box attached to the backplane of the front side and near the door opposing the external service disconnect on the side wall of the back side. Each junction box shall be constructed of drawn or welded steel and have a minimum depth of 1.25 inches. Each junction box shall include knockouts and clamps for conduit and cables, as appropriate. Steel box covers shall be provided with each junction box as appropriate for a duplex receptacle or a duplex GFCI receptacle.

A duplex NEMA 5-15R GFCI receptacle shall be provided within the outlet box mounted to the backplane of the front side. NEMA 5-15R GFCI receptacles shall be rated for 125 VAC, 0.5 HP and 15 A. It shall be of commercial grade quality and manufactured from high strength nylon.

A duplex NEMA 5-15R receptacle shall be provided on the back side within the outlet box opposing the external service disconnect. The NEMA 5-15R receptacle shall be rated for 125 VAC, 0.5 HP and 15 A. It shall be of commercial grade quality and be manufactured from high strength nylon. The NEMA 5-15 receptacle shall have two poles, three wires and include a self-grounding strap to insure ground contact.

Both duplex NEMA 5-15R and duplex NEMA 5-15R GFCI receptacles shall be UL listed.

Power Conditioner (Back Side): The power conditioner shall be installed in the cabinet to provide both fully regenerated, conditioned power with true sine wave and continuous AC outputs to controllers and communication devices, simultaneously. The power conditioner shall be designed for outdoor use, support an operating temperature range of -40°F to +165°F, be operational in humidity levels of 0% to 95% (non-condensing) and operate at an altitude ranging from sea level to two miles above sea level. It shall utilize an input voltage of 120 VAC, 40 to 70 Hz and an output voltage of 120 VAC (± 3%), user selectable 50 to 60 Hz (± 0.25%). The power conditioner shall support a maximum output of 1400W at 120 V. It shall have a total harmonic distortion not exceeding 3.0%. The power conditioner shall utilize input and output electrical connectors conforming to the IEC 60320-1 *Appliance Couplers for Household and Similar General Purposes* specification. Its dimensions shall not exceed 1.7 inches (H) × 11 inches (W) × 8.5 inches (D) and its weight shall not exceed 5 lbs. One power conditioner shall be provided with each communications cabinet.

Six Outlet Power Strip (Front Side): An integral component of the power conditioner shall be a factory-installed power strip. The power strip shall have six front facing NEMA Type 5-20R outlets. The power strip shall be rated for 20 A at 120 VAC. It shall have an energy rating of 630 Joules, clamping voltage of 500 V and EMI/RFI noise filter of 150 KHz to 100 MHz at up to 43 dB. The power strip shall have a recessed power switch and a power cord of not less than 2.5 feet. The dimensions of the power strip shall be 10 inches (L) × 1.63 inches (W).

DIN Rails (Front Side): Each communications cabinet shall utilize standard 1.38 inch DIN rails. The DIN rails shall be of steel construction with a coating for corrosion resistance. The DIN rails shall utilize 0.25 inch × 0.71 inch slots for fastening to the back panel located in each communications cabinet. The spacing of the DIN rail slots shall be 0.98 inch center-to-center. DIN rails and associated mounting hardware for attachment to the back panel shall be provided with each communications cabinet.

12 VDC Power Supply (Front Side): The 12 VDC power supply shall support an input voltage range of 85-264 VAC and frequency range of 47-63 Hz. It shall have a typical efficiency of at least 76% and typical AC current of 1.6 A at 115 VAC. The 12 VDC power supply shall provide an output voltage of 12 VDC and have a current rating of 6.3 A. It shall support an output current range of 0 to 6.3 A and have a rated power of 75 W. The 12 VDC power supply shall have overload protection of 105-150% for its rated output power and overvoltage protection for voltages of 15-16.5 VDC. It shall be designed for an operating temperature of +14°F to +140°F and humidity levels of 20% to 90% (non-condensing). The 12 VDC power supply shall conform to the following standards: IEC 60068-2-6 Environmental Testing (Vibration) and UL 508 Industrial Control Equipment. It shall be DIN rail mountable, have dimensions not exceeding 5 inches (h) × 2.25 inches (w) × 4 inches (d) and a weight of not more than 1.5 lb. One 12 VDC power supply shall be provided with each communications cabinet.

Load Center: Each load center shall be readily accessible and installed on the exterior of the cabinet close to the door on the back side, positioned not more than 6 feet 7 inches above the ground or as required per Article 240.24 of the NEC. The neutral from the power source or service enclosure shall be connected to the ground bar in the load center. The ground bar shall be connected to the service disconnect using a bonding strap. The ground bar shall be connected to a grounding electrode using grounding conductors conforming to the requirements of Article 250.122 of the NEC. The grounding electrode shall conform to the requirements of Articles 250.52 through 250.70 of the NEC. The load center shall feed a duplex NEMA 5-15R mounted on the inside of the cabinet.

Foundation: Each Communication Cabinet (Type 2) that is to be ground-mounted shall include a polymer concrete or poured concrete pad that extends at least 2'-6" beyond the cabinet base on each cabinet door side and at least 6" beyond the cabinet base on the other two sides. There shall also be an 18" high aluminum riser. The bottom of this riser shall be solidly connected to the pad. The riser shall include connection mechanisms to which the cabinet can be attached.

CONSTRUCTION REQUIREMENTS

Each communications cabinet shall have tapped pads to provide for the mounting of a back panel as specified herein.

The cabinet backplane shall be adjusted in depth to allow mounting of a 10 inch deep Ethernet switch on the front side rack rails.

Mounting of equipment and hardware onto the back panel shall be through the use of self-tapping screws or Velcro Extreme as required per the Plans. Self-tapping screws shall be of appropriate size for the equipment or hardware being installed onto the back panel. The length of the self-tapping screw shall not exceed a ½ inch and the bit recess in the screw head shall be hexagonal.

The power conditioner and battery shall be mounted to the back plane on the back side of the cabinet such that cooling vents remain unobstructed. The power strip shall be mounted on the back panel on the front side of the cabinet as shown in the Plans.

DIN rail, and 12 V DCD power supply shall be mounted to the back panel on the front of the cabinet to allow for current and future equipment.

Conduit accesses into the cabinet for electrical wiring, specific field device low-voltage control cabling, and fiber optic cabling, shall be plugged with a manual plug (no foam sealant is allowed).

Cable management and strain relief shall be employed within the communications cabinet. Cables shall be labeled and neatly organized using cable ties and/or Velcro. Velcro shall be used on fiber optic jumper cables or bundles of cables containing fiber optic jumper cables. Unused spaces within the back panel and interior wall of the communications cabinet may be used to facilitate cable management, but installation of cable management hardware that penetrate the interior walls of the communications cabinet shall not be permitted.

REVISION OF SECTION 614
CONTROLLER CABINET FOUNDATION

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing a fiberglass porch-style traffic signal controller base in the field for 334 traffic signal controller cabinet foundations at ramp meter locations.

MATERIALS

Section 614.10 (e) shall include the following:

Controller foundations shall be preformed type and shall meet the following requirements:

Controller foundation shall be manufactured of fiberglass reinforced polymer concrete. A minimum of 4 - ½ inch x 13 Unified Coarse Thread (UNC) inserts shall be installed for mounting of the controller cabinet to the foundation. Placement of the mounting inserts shall match the mounting configuration of the controller cabinet. The foundation shall be provided with an opening to accommodate access of underground conduit into the controller cabinet. Foundation opening shall match the controller cabinet opening as closely as possible. A minimum of 4 – ½ inch x 13 UNC lifting inserts shall be installed at each corner of the controller cabinet foundation. Lifting inserts shall be designed to support the full weight of the foundation to aid in the moving and placing of the foundation. The walking surface of the foundation shall have a skid resistant surface encompassing three sides of the controller cabinet so field personnel can walk on the foundation from the front door to the back cabinet door.

REVISION OF SECTION 614
DISINCENTIVE FOR ITS OFFLINE DEVICES

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of the maintenance of Intelligent Transportation System (ITS) devices during resetting and reconfiguring for testing communication, and performing cutovers.

Offline, as used in this specification, is defined as time during which data or video is not being received by a Colorado Operations Center or ITS Traffic Management System Building.

CONSTRUCTION REQUIREMENTS

Anytime the Contractor plans to perform work on an ITS device and an outage is not planned, the Contractor shall provide CDOT ITS with a one day advance notification using the attached form. This advance notice, as well as those described below for planned outages, shall be provided to Jill Scott at jill.scott@state.co.us by the Project Engineer.

(a) Planned ITS Outages

A "planned outage" is considered to be any loss of device functionality or communication that can be anticipated in advance due to work activities within or related to the Project. For planned outages, CDOT ITS shall be given proper advance notice as described below. All proposed equipment, power, and all temporary communications necessary for maintaining ITS devices during construction shall be constructed and put in place prior to the cutover or reset in order to minimize downtime of devices.

(1) ITS Network: The Contractor shall submit a fiber optic backbone cutover plan to CDOT ITS for review two weeks prior to performing the work, as well as a one week advance notice to CDOT ITS of any fiber optic backbone cutover work. This cutover plan shall detail how the Contractor will sequence the construction activities, so that the new backbone is installed and spliced into the existing devices and the node building such that 12-hours of downtime is not exceeded. CDOT's network fibers shall be spliced first in the sequence. The fiber optic backbone splicing shall be scheduled for an overnight shift such that the ITS network shall be fully functional by 4 AM and the remaining cable is complete by 9 AM, unless otherwise approved by the Engineer. The fiber optic backbone splicing shall be scheduled between Tuesday and Thursday, except holidays, unless otherwise approved by the Engineer.

For work on node locations, the Engineer shall be notified about the need to shut down power in order to perform electrical wiring work at least 48 hours before the power needs to be shut down. Additionally, the Engineer shall be notified the day before the shutdown and on the morning of the day of the shutdown. Power shall be turned off in a responsible manner that will not harm existing node components. All necessary precautions and preparations shall be made and coordinated with CDOT prior to power being turned off.

Power may not be off for a period of longer than 45 minutes unless specifically authorized by the Engineer.

(2) ITS Devices: The Contractor shall provide a 72-hour advance notice to CDOT ITS to coordinate any downtime for ITS devices for a planned outage. Allowable offline periods for ITS field devices shall be a 48-hour period scheduled between Tuesday and Thursday, excluding holidays, unless otherwise approved by the Engineer. For planned outages where CDOT ITS receives this advance notice, the Contractor shall be charged a disincentive of $50 per hour per each device that is offline beyond the 48 hour allowable offline period. ITS field devices covered under this special provision include, but are not limited to, CCTVs, MVRDs, RWISs, TTIs, ramp meters, VMSs, dopplers, and ATRs. No more than two ITS devices shall be inoperable at any one time.

For locations with new poles, all work on the new pole including installation of the cabinet, power, pull boxes, and fiber optic cables shall be advanced to the greatest possible degree of completion before any part of the existing system is disturbed. Once it becomes necessary to disturb the existing system at a given location, work at that location shall progress continuously until the new installation is up and running.

To the greatest possible degree, installation of in-cabinet elements into new cabinets shall be done at locations where no construction traffic control is required.

(b) Unplanned ITS Outages

An "unplanned outage" is considered to be any loss of network communications or device functionality that CDOT ITS does not receive proper advance notice, as described above, or is due to the Contractor's negligence, act or omission under their control.

(1) ITS Network: If the Contractor damages a CDOT ITS fiber optic backbone, or if CDOT ITS loses communications or power to an ITS Traffic Management System Building or operations center as a result of the Contractor's negligence, act or omission under their control, the Contractor shall be charged a disincentive. This first time network disincentive rate shall be $1,000 per hour, and an additional $2,000 per hour for a communications or power outage that results in loss of data and video to an ITS Traffic Management System Building or operations center.

This disincentive rate shall increase to $2,000 per hour the second time, and an additional $3,000 per hour for a communications or power outage that results in loss of data and video to a node building or operations center. This increase of $1,000 per hour will continue for any further outages to the CDOT Network.

Additionally, the Contractor will be responsible for any charges involved with investigating such an outage and restoration of the ITS network to full working condition. These disincentive rates are in addition to the private industries loss of communications.

(2) ITS Devices: For unplanned outages or outages where CDOT ITS does not receive advance notification, the Contractor shall be charged a disincentive of $50 per hour per each device that is offline beginning at the time of the outage.

This disincentive is not a penalty, but is based on costs associated with the disruption of information to the traveling public.

There will be no incentive paid for this work.

The disincentive will be deducted from any monies owed to the Contractor for work performed.

In addition to those disincentives described above, the Contractor will be responsible to pay any penalties charged by private utility owners as a result of damage to their facilities.

COLORADO DEPARTMENT OF TRANSPORTATION

TEMPORARY OFFLINE ITS DEVICE NOTIFICATION

Project Description / Location:		Project #:	Project Code (SA #):
Project Engineer:	Project Engineer Contact #:	Date:	
Contractor:	Contractor Representative:	Contractor Rep Contact #:	

Device Type (VMS, CCTV...)	Highway / Direction (NB I-25)	Mile Marker (241.69)	Description of Device Location (North of St. Vrain River, US-34 Interchange...)	Offline Date (10/26/15)	Estimated Down Time (48 Hours)	Online Date (10/29/15)

Contractor Notes:

Maintenance Notes:

CDOT Form # XXXX 6/15

REVISION OF SECTION 614
DEDICATED SHORT RANGE COMMUNICATIONS (DSRC) ROADSIDE UNIT

Section 614 is hereby added to the Standard Specifications for this project as follows:

DESCRIPTION

The Dedicated Short Range Communications (DSRC) Roadside Unit (RSU) is a short to medium range communications device that provides information and supports Public Safety operations in roadside to vehicle and vehicle to vehicle communication environments. The Roadside Unit is a grade electronic module that must be capable of both transmitting and receiving using DSRC radios, using the 5.9 Gigahertz (GHz) band approved for DSRC use by the Federal Communications Commission (FCC). DSRC is a two-way wireless communication protocol that integrates and implements the appropriate Institute of Electrical and Electronics Engineers (IEEE), and the Society of Automotive Engineers (SAE) standards (IEEE 802.11p, IEEE 1609 family, and SAE J2735 message set dictionary).

MATERIALS

The RSU shall be enclosed a single enclosed unit with dual radios, powered through the Ethernet Interface. The 5.9.GHz DSRC radios on the board should be connected to the external Antenna 1 and Antenna 2 interfaces. The board contains a main processor running a Linux–based operating system, working in conjunction with additional processors running the DSRC Software Defined Radios. The RSU should have on board GPS for location services and synchronization, a Power Over Ethernet (PoE) or AC power source with full surge protection, remote management support, an available software development kit (SDK) for application development, and logging and error reporting.

The RSU shall be shipped with a *Global Navigation Satellite System (*GNSS) antenna and two 5.9GHz omni antennas with external lightning protection.

(1) 28±2 dB GNSS antenna
(2) 5.9GHz Omni Antenna
(3) 0-6 GHz Lightning Surge Protection

The minimum requirements for processing, memory, and storage shall be:

(1) Processing: 500 MHZ
(2) Memory: 256MB DDR RAM
(3) Storage: 8GB compact flash

(a) RSU Environmental Conditions.

The RSU shall conform to the following environmental conditions:

(1) Operating temperature range: (-40° Celsius to +65° Celsius) (-30° Fahrenheit to +165° Fahrenheit)
(2) Storage temperature range: (-40° Celsius to +85° Celsius) (-30° Fahrenheit to +185° Fahrenheit)

(3) Operating shock and Vibration: United States Department Of Defense, Military Standard (MIL-STD) 810G, Method 514 and 516
(4) Salt fog: United States Department Of Defense, Military Standard (MIL-STD) 810G, Method 509
(5) Wind: The roadside unit mounting bracket shall be able to withstand winds up to 110 miles per hour per American Association of State Highway and Transportation Officials (AASHTO) 2013, Sixth Edition of the AASHTO Standard Specification for the Supports for Highway Signs, Luminaires and Traffic Signals, with the most recent Interim Revisions

(b) RSU Performance

(1) *Mean Time Between Failure* MTBF: The roadside unit shall remain operational for an average of 100,000 hours under normal environmental conditions.
(2) The roadside unit shall meet the operational availability requirements of 99.9%.
(3) DSRC Radio Receive Range: The roadside unit shall receive DSRC messages throughout a range of 1m to 300m (1ft to 984ft), with a maximum Packet Error Rate of 10.0%, in an open field under the following conditions:
    a) When receiving on an 802.11p Regulatory class 17 channel(even 10 MHz Service Channel, numbers 172 through 184).
    b) When receiving Part 1 of the SAE J2735 defined Basic Safety Message (BSM)
    c) With a BSM transmit rate of 10 Hz
    d) With a Data Rate of 6 Mbps
    e) With an RSU antenna centerline height of 8 meters
    f) With a maximum Basic Safety Message (BSM) transmit Equivalent Isotropically Radiated Power EIRP
(4) DSRC Radio Transmission Range: The roadside unit shall transmit DSRC messages throughout a range of 1m to 300m (1ft to 984ft), with a maximum Packet Error Rate of 10.0%, in an open field under the following conditions:
    a) When transmitting on an 802.11p Regulatory class 17 channel (even 10 MHz Service Channel, numbers 172 through 184).
    b) When transmitting Wave Service Advertisements (WSA), as defined in IEEE 1609.3
    c) With a WSA Transmission Rate of 10 Hz
    d) With a Data Rate of 6 Mbps

(c) RSU Enclosure.

The enclosure shall be designed to comply with the following NEMA requirements:

(1) Providing a degree of protection to personnel against access to hazardous parts (indoor/outdoor use)
(2) Provide protection of the equipment inside the enclosure against ingress of solid foreign objects, falling dirt and windblown dust.
(3) Provide protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water and hose directed water); and that will be undamaged by the external formation of ice on the enclosure.

The enclosure shall provide:

(1) Protection classification: *National Electrical Manufacturers Association (*NEMA) 4X, Ingress Protection (IP) 66 rating
(2) Provision for the following waterproof (IP66) connector interfaces
(3) One Ethernet RJ45,
    a) IEEE 802.3 10BASE-T, 802.3u 100BASE-TX, PoE 802.3af (Mode A and Mode B)
    b) Input Voltage: 36 to 57Vdc.
    c) Pin Configuration: 3/6, 1/2 or 4/5, 7/8
(4) Three N-Type (F) Radio Frequency (RF) connectors (one GNSS and two 5.9GHz connectors)
(5) Status Indication: The roadside unit shall include a light-emitting diode (LED) to indicate the operational status of the device in accordance with the following protocol: Off – No, Power Blinking Green – Device, Start-Up Solid Green - Device Operational, Amber - Firmware Update in Progress Red-Fault
(6) Multipin Digital Interface (Serial Console)
(7) The external PoE connector shall be compliant with the Outdoor IP66 rating.
(8) Internal heat spreader
(9) Die-cast Aluminum with a Powder-Coat finish and complete set of mounting holes to suit the particular PCB variant.

(d) RSU Board.

The Board shall be designed to provide a compact platform for the deployment of advanced connected vehicle applications and protocol stacks to enhance the performance of the DSRC Radio in mobile environments.

The Board shall provide:

(1) Single or Dual channel IEEE 802.11p radio
(2) IEEE 1609.1-4 protocol stacks, including security functions
(3) Advanced vehicle positioning system, including
    a) Advanced GNSS positioning system
    b) Optional Dead Reckoning (DR) using vehicle sensors via Controller Area Network (CAN) bus or VIC inputs
(4) High performance application processor for execution of ITS and safety applications
    a) Processor
    b) DDR memory
    c) Linux operating system
(5) Interface options
    a) Ethernet Internet Protocol Version(IP v)4/IPv6 networking)
    b) *Universal Serial Bus* (USB) 2.0 high-speed, on-the-go (host/peripheral)
    c) Serial Console (Internal)
    d) High speed CAN bus interface on VIC connector

The Application Processor should run the latest Linux operating system, and ITS applications should be written as Linux application software. Non-volatile (flash memory) storage is accessible via standard Linux file-systems, and user interface devices are accessed via standard Linux Application Programming Interface (API).

(e) DSRC Radio Transceiver.

The DSRC radio should be comprised of the following components; Physical Layer Radio Transceiver (PHY), RF, and Medium Access Control (MAC) as described below:

(1) Physical Layer Radio Transceiver (PHY).

The physical layer radio transceiver (PHY) shall be IEEE 802.11p compliant which employs advanced mobility receiver algorithms. The PHY RF front-end must provide multiple radio configurations, allowing the Carrier Board to implement single or dual radio DSRC systems.

The RF sub-system provides separate antenna ports for 5GHz bands.

The PHY shall provide 2-antenna diversity transmission and reception for optimum radio performance. The required operating modes and functionality of the PHY are as follows:

a) Single-channel mode for (1 or 2 antenna diversity operation) and dual-channel mode (1 antenna per channel), 2 independent IEEE 802.11p for radios operating on different radio channels.
b) 10MHz, (DSRC) channel bandwidth modes.
c) Dual five GHz RF paths (5.18 GHz to 5.93 GHz)
d) Transmit mask meeting IEEE 802.11p Class C (5GHz band).
e) IEEE 802.11p enhanced adjacent channel receiver performance.
f) Transmit antenna cyclic delay diversity (2 antenna operation only).

(2) Medium Access Control Layer.

The MAC shall be IEEE 802.11p compliant and provide fast, time-synchronized channel switching functionality. It should also provide support for multiple queue sets, allowing packets to be queued while the PHY/MAC is operating on another channel.

The MAC shall provide the following operating modes:

a) Channel switching between 2 channels with independent sets of transmit queues.
b) Single radio, time-synchronized multi-channel operation
c) Simple single radio channel operation
d) Dual-radio, multi-channel operation
e) Independent MAC/PHY entities operating concurrently on different radio channels.
f) Optional coordination between channels to avoid self-interference when operating on close radio channels.
g) Dual radio time synchronized multichannel operation.

Other features of the MAC should include Radio Channel Measurements, comprising the following:

a) Channel utilization (ratio of channel busy time to measurement duration)
b) Channel active ratio (proportion of time that the radio is tuned to the Service Channel (SCH) or Control Channel (CCH), respectively)

c) Per-channel statistics (number of packets successfully transmitted, number of packets that failed to transmit, number of packets successfully received, and number of packets received in error. Broken down according to broadcast, multicast, and unicast packets).
d) Received signal and noise power levels

(3) Processor.

The processor shall utilize the Linux operating system and provide flexibility for running multiple applications. The processor shall provide ample processing power for the ITS applications.

A wide selection of services available to applications should be provided, not limited to the following:

a) Communication services.

The system shall provide a range of communication services for ITS applications. All communication services should be integrated within the Linux networking system. The following network protocols should be provided by the platform:

i. IPv6, IPv4 (Linux networking stack)
ii. IEEE1609.3 WSMP and WME management
iii. ETSI TC-ITS G5, GN, GN6 & BTP

These communication protocols should have the capability to operate over the following communication interfaces available on the Unit board namely 10/100Mbps Ethernet and USB 2.0.

b) Ethernet.

The Unit processor shall provide a 100Mbps Ethernet interface (10BASE-T/100BASE-TX) which can be used as part of an application or alternatively used for debugging purposes or remote status and control. The Ethernet interface should be supported by Linux Ethernet device drivers, providing full IPv4/IPv6 over-Ethernet networking functionality.

c) Peripheral Interface Services.

General purpose interface services should be provided to allow interconnection with external peripheral devices and systems.

d) USB-OTG.

A USB 2.0 on-the-go (OTG) port should be available on the Unit Board, and shall be supported by Linux USB host and peripheral device driver APIs.

e) Serial Console.

The Unit Board may provide an optional serial port upgrade via the expansion connector through which the primary operating system console becomes available.

This port should be used primarily for system development and debug operations, but may also be used by applications.

f) Security Services

The Unit Board shall provide hardware security services necessary to support the IEEE 1609.2 and ETSI TS 102 867 standards.

g) Add of field and/or remote upgrade feature to allow messages sets, firmware, application updates.

(f) Certification Requirements.

The Roadside Unit must conform to the US Department of Transportations' current version of "DSRC Roadside Unit Specifications Document" and OmniAir certifications. OmniAir certification incorporates specific Wi-Fi and FCC requirements. To ensure conformance with DOT standards, the selected vendor should be on the United States Department of Transportation (USDOT) Research Qualified Products List (rQPL).

(g) System Software Requirements.

The RSU software is an application that will run on Wireless DSRC radios. The RSU software shall be able to perform the following requirements, at a minimum:

(1) Broadcast SAE J2735 messages over the DSRC radio
(2) Receive Wave Short Messages (WSM)
(3) Route and forward IPv6 traffic for connected mobile units
(4) Capture Communication Message Log (CML)
(5) Capture System Status Log (SSL)
(6) Transmit periodic heartbeat messages

(h) Software Environment.

The software environment shall be a Linux-based operating system which utilizes both Python and C-based components, or other equipment components which perform the requirements.

(i) Ethernet Interface.

The RSU software running on the DSRC radio utilizes the Ethernet interface to combine functions of both the Remote System interface (RSI) and the Local System Interface (LSI). This interface shall be able to perform the following requirements, at a minimum:

(1) Successfully login to the RSU with the ability to start and stop the application and set configuration parameters
(2) The ability to add, delete and modify active list messages
(3) Transmit unicast heartbeat messages to a remote host
(4) Accept SAE J2735 messages for immediate forwarding on the DSRC radio interface
(5) Off-loading log messages about system status and communication history of the device.

(j) Summary of Software Operation.

The RSU software shall run on Wireless DSRC radio units and perform the following functions, at a minimum:

(1) Broadcast SAE J2735 messages on the DSRC radio interface and monitor for forwarded SAE J2735 messages on its Ethernet interface to broadcast on the DSRC radio interface.
(2) Log transmitted and received messages on DSRC radio interface (CML)
(3) Logssystem status messages (System Status Log
(4) Receive Wave Short Messages (WSM)
(5) Transmit Wave Service Announcements (WSA)
(6) Route IPv6 traffic for connected mobile units
(7) Transmit periodic heartbeat messages
(8) Ensure message signing and verification in accordance with IEEE 1609.2 requirements.

(k) System Interfaces.

A brief description of these interfaces is provided below:

Interfacee	Description
Antenna 1 / 2	5.9 GHz N-Type Male for DSRC radio
LED	Multi-color Light Emitting Diode (LED)
USB	USB Type A female (Optional). If USB is not required, a sealed plug may be used.
Digital Interface	Ingress Protection rated connector providing RS232 serial
Ethernet	Ethernet socket with Power over Ethernet
GNSS Antenna	Global Navigation Satellite antenna connector (N-Type Male connector)

(l) DSRC Antenna Interfaces.

(1) The RSU provides a single DSRC radio set, denoted by interfaces Antenna 1 and ANT2.
a) USB Interface (Optional).

The USB interface is an IP67 rated USB-Type A Female connector with a threaded collar to provide a tight seal against water and dust.

b) Ethernet Interface.

The Ethernet socket takes a RJ45 plug and connects to an internal Power over Ethernet Splitter providing separate power and Ethernet to the board. The internal PoE splitter is configured to support 802.3af Mode A/B.

c) GNSS Interface.

The RSU provides a GNSS interface to receive global positioning data transmitted by satellites.

(m) Connected Vehicle Applications.

Dedicated Short Range Communications has evolved significantly over the last 20 years. It is expected that the installed roadside units shall have the capability and flexibility to be integrated with various mobility, safety, and data applications within the Colorado Department of Transportation.

CONSTRUCTION REQUIREMENTS

(a) Installation Requirements.

(1) Powering the Roadside Unit (RSU)

The PoE splitter, internal to the RSU, shall be configured to connect to a PoE (802.3af) Mode A/B Power Supply Equipment (PSE), supplying 48V DC or 110VAC over the Ethernet interface. If the installation site does not support 802.3af, then an additional PoE Injector taking DC input and supplying 48V DC 802.3af Mode A/B output will be required to power the unit. The maximum distance between the PSE and the Powered Device (PD), and the RSU, shall be 100 meters (328 feet). Providing power beyond 100 meters requires an additional PoE extender. Power consumption for the RSU shall not exceed 24 Watts.

(2) RSU Antenna Connections.

The RSU requires Omni-directional antenna connected to each DSRC radio and a Global Positioning System (GPS) Antenna connected to the GNSS interface. All Radio Frequency (RF) connectors and lightning surge arresters shall be weatherproofed with self-fusing rubber tape.

(3) Lightning Surge Arresters.

The DSRC radios and GNSS receiver on the RSU can be protected by attaching optional Lightning Surge Arresters. If lightning surge arresters are to be fitted, they must be connected directly to the RSU Antenna 1, Antenna 2 and GNSS interfaces. All lightning surge arresters shall be connected to a common earthing/grounding point. An earth grounding wire must be attached to the body of each lightning surge arrester. The earth grounding wires should be connected to same common earth ground point used by the RSU.

(4) Omni Directional Antenna.

An optional Lightning Surge Arrester can be connected in-line with each DSRC radio. An earth grounding wire must be attached to the body of each lightning surge arrester. The earth grounding wires are connected to same common earth ground point used by the RSU. The RSU requires Omni-directional antenna connected to each DSRC radio and a Global Positioning System (GPS) Antenna connected to the GNSS interface. All Radio Frequency (RF) connectors and lightning surge arresters shall be weatherproofed with self-fusing rubber tape.

(5) Pole Mounting.

The RSU shall have a flat surface, with equally spaced mounting holes and is capable of accepting an optional mounting bracket. The mounting bracket should be attached to facilitate mounting to a vertical or horizontal pole. Adjustable stainless steel straps

can be threaded through slots in the mounting bracket to fasten the mounting bracket to the pole. When attaching an RSU to a horizontal pole, the minimum recommended separation between the pole and the Antenna closest to the pole is 2 meters (6.56 feet). For vertical mounting of an RSU, the mounting height of the RSU unit and varies based on roadway topology and ensuring the optimal line of sight.

(b) DSRC Radio Interface.

The RSU software running on the DSRC radio shall utilize the DSRC Radio interface to broadcast SAE J2735 messages, transmit Wave Service Announcements (WSA), traveler information messages, Radio Technical Commission for Maritime Services (RTCM) messages, and Geometric Intersection Description (GID)/MAP messages. Dual Radio support must be provided. The following networking support is required, namely:

(1) IPv6
(2) IPv4
(3) Simple Internet Transition (SIT) Tunnel Support
(4) System Status Log (SSL)
(5) Secure Shell (SSH)
(6) *Transport Layer Security* (TLS)

(c) Software installation

The RSU software shall run on Wireless DSRC radio units and incorporate field-proven Network Layer, Facilities Layer, and Applications Layer software libraries. In addition, the SDK shall allow users to develop their own applications and customize the system

All DSRC radios/RSU software on this project shall include licensing for centralized manufacturer management software capable of remote device discovery, real-time device monitoring, troubleshooting, diagnostics, and automated configuration management

REVISION OF SECTION 614
ETHERNET ROUTER (5160)

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

For this project, Ethernet Router shall be a Ciena 5160 Carrier Ethernet Service Aggregation Switch, utilizing SFP+ optic modules, installed in the existing County Line communication node building to aggregate local and remote Ciena 5150 Carrier Ethernet Service Aggregation Switches at 10 Gbps. The Ciena 5160 Carrier Ethernet Service Aggregation Switch shall interface to an existing Ciena 6500 Packet-Optical Platform at 10 Gbps, unless otherwise specified by CDOT.

The Ciena 5160 Carrier Ethernet Service Aggregation Switch shall have the ability to accept up to a maximum of twenty-four (24) 1Gig or 10 Gig multi-rate SFP+ ports. All XFP optic modules for Ciena 5150s that will interface with the Ciena 5160 as part of this project shall be provided by the Contractor. Additionally, the SFP+ optic module for the Ciena 5160 that is needed to interface with both the Ciena 5150 and 6500 shall also be provided by the Contractor.

A single mode, 9/125um optical attenuator to match the wavelength of the XFP optic modules shall be included and installed in the receive port of the XFP on each Ciena 5150 interfacing with the Ciena 5160, unless otherwise specified by the Engineer. Single mode, 9/125um optical attenuators to match the wavelength of the SFP+ optic module shall be included and installed in the receive port of the SFP+ on the Ciena 5160, unless otherwise specified by the Engineer. Optical attenuators shall also be provided by the Contractor.

MATERIALS

The Ciena 5160 Carrier Ethernet Service Aggregation Switch shall be configured with twenty-four (24) 10G SFP+ ports, one (1) 10/100/1000M RJ-45 management port, one (1) console port (RJ-45, EIA-561), sixteen (16) external alarm inputs, one (1) RJ-45 sync input/output port and two (2) SMB sync input/output ports.

The Contractor shall furnish and install the Ciena 5160 Carrier Ethernet Service Aggregation Switch and associated items shown in Item Table A below. The Contractor shall also furnish the Ethernet switch software and maintenance licenses show in Item Tables B and C. Tables A, B and C describe items to be included with a single 5160 Carrier Ethernet Service Aggregation Switch.

Item Table A – Ciena 5160 Carrier Ethernet SAS Switch, Hardware Description

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
5160,(24)1G/10G SFP+, (2)SLOTS AC OR DC PLUG POWER SUPPLY	170-5160-900	1
5160, AC PLUGGABLE POWER SUPPLY, WIDE RANGE 120/240V	170-0070-900	2
AC POWER CORD, IEC C13, 5-15P,125VAC,10A, 10FT	170-0044-900	2
DB-9F TO EIA-RJ45M STANDARD, 6 FT SERIAL CONSOLE CABLE	170-0063-900	1
10/100/1000M, SFP TRANSCEIVER, RJ45 CONNECTOR, SGMII, 100 METERS, RX LOS, EXTENDED TEMPERATURE (FOR EXISTING 5150 ONLY)	XCVR-B00CRJ	AS REQUIRED
10GIG, MM XFP OPTIC, LC CONNECTOR, 300 METERS, 850 NM, EXTENDED TEMPERATURE (FOR EXISTING 5150 ONLY)	XCVR-A00Z85	AS REQUIRED
10GIG, MM SFP+, LC CONNECTOR, 300 METERS, 850 NM, EXTENDED TEMPERATURE	XCVR-S00Z85	AS REQUIRED
10GIG,SM SFP+,LC CONNECTOR, 10 KM,1310 NM, EXTENDED TEMPERATURE	XCVR-S10V31	AS REQUIRED
10 GIG, SM SFP+, LC CONNECTOR, 40 KM, 1550 NM, EXTENDED TEMPERATURE	XCVR-S40V55	AS REQUIRED
10GIG, SM SFP+, LC CONNECTOR, 80 KM, 1550 NM, EXTENDED TEMPERATURE	XCVR-S80V55	AS REQUIRED
SFP+, 10GE/FC1200, 850 NM (FOR EXISTING 6500 ONLY)*	160-9111-900*	AS REQUIRED

*Assumes 5160 will interface to a 4x10G OTR card (NTK530QA) in existing 6500; designer to confirm with CDOT.

Item Table B – Ciena 5160 Carrier Ethernet SAS Switch, Software Description

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
SAOS ADVANCED ETHERNET PERPETUAL SOFTWARE LICENSE FOR 5160 SYSTEM	S70-0017-900	1
SAOS ADVANCED OAM PERPETUAL SOFTWARE LICENSE FOR 5160 SYSTEM	S70-0017-901	1
SAOS ADVANCED SECURITY PERPETUAL SOFTWARE LICENSE FOR USE WITH SAOS 6.X	170-0204-900	1
ESM CARRIER ED RIGHT TO MANAGE PERPETUAL SOFTWARE LICENSE FOR 5160 SYSTEM	S70-0018-900	1

Item Table C – Ciena 5160 Carrier Ethernet SAS Switch, Maintenance License

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
GLOBAL 5160 SMARTSUPPORT - 3 YEARS	80M-5160-SSP	1
GLOBAL 5160 STANDARD HARDWARE REPAIR 10-DAY - 3 YEARS	80M-5160-HWM	1
GLOBAL 5160 NEXT BUSINESS DAY SHIP MANAGED SPARES - 3 YEARS	80M-5160-NBS	1

All associated hardware and materials not listed in the item tables are considered subsidiary and required for a complete installation and shall be included as part of the work.

Final configuration including all IP schema design for data transport will be conducted by CDOT personnel after installation.

If field changes are made which affect the original Contractor's material order for the Ethernet switches and require any reconfiguration of the original Ethernet switch material orders, the Contractor shall ensure that the Ciena representative is contacted and made aware of such changes to alleviate any possible delays in delivery and installation. If for any reason the switch or associated materials are defective or are damaged at the time of installation by either the Contractor or by Ciena, the item shall be removed and replaced at no additional cost to the project. Items shall also be replaced if any failures occur due to manufacturer's defects, at no additional cost to the project, prior to the final acceptance.

CenturyLink is the direct contracted equipment supplier of Ciena Corporation for the State of Colorado, Colorado Department of Transportation for networking equipment and associated network materials. For project equipment estimate quotations and purchasing, Contractors shall contact the following distributer representative:

Project equipment, equipment estimates, and purchasing distributer representative:

Keith A. Glose

Premier Account Manager

CenturyLink Government

930 15th Street, 4th Floor, Denver, Colorado 80202

Telephone: 303-992-5567 Fax: 720-578-2694

E-Mail: keith.glose@centurylink.com

Neither CenturyLink nor Ciena Corporation will be involved in the design of the project corridor network. The Contractor shall contact the CenturyLink representative for equipment quotations and purchasing purposes only. The Contractor shall not contact or rely on either CenturyLink or Ciena for network design related questions.

When requesting quotations, the Contractor shall submit to CenturyLink a complete package including the following items:

- A complete list of required equipment for purchase including materials and quantities based on the individual project specifications to achieve a complete item(s) installation.
- A PDF copy of all project specifications pertaining to the material being ordered.
- A PDF copy of all networking project plan sheets.

It is the Contractor's responsibility to provide the distributer's representative all information required pertaining to the complete network design. During the project, CenturyLink or Ciena Corporation is not responsible for any type of network design aide. All questions pertaining to the network design shall be conducted through the Project Engineer for help or clarification.

CONSTRUCTION REQUIREMENTS

The 5160 SAS Ethernet switch shall be installed in the existing County Line communications node buildings and will be connected via fiber to local and remote 5150s. The 5160 SAS Ethernet switch shall also be connected to the existing Ciena 6500, unless otherwise specified by CDOT.

For 5160 connection to remote 5150s, the Contractor shall install single mode, bend insensitive, pre-connectorized duplex patch cables with a polyurethane jacket for connection from the fiber optic termination panel to the SFP+ optic modules in the Ciena 5160. The Contractor shall also install single mode, bend insensitive, pre-connectorized duplex patch cables with a polyurethane jacket for connection from the local 5150 XFP optic module to the SFP+ optic modules in the Ciena 5160 located in the same node building. Connectors for the patch cable shall be LC for the XFP and SFP+ optic modules and LC for the fiber optic termination panel.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
ETHERNET SWITCH 3930

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

For this project Ethernet Switch shall be a Ciena 3930 Carrier Ethernet Service Delivery Switch (SDS) for installation in individual Intelligent Transportation Systems (ITS) device communication cabinets and/or variable message sign cabinets to transport Ethernet data to and from a regeneration node building or the CTMC and roadway ITS devices. All Ethernet switches shall be manufactured by Ciena.

The Ethernet switch shall utilize Coarse Wavelength Division Multiplexing (CWDM) and Small Form-factor Pluggable (SFP) optic modules. Each switch shall be provided with both a CWDM SFP optic module and a 1310 nm SFP optic module where a two switch per wavelength deployment is utilized (typical design). The Contractor is advised that in certain cases there are more than two switches per wavelength and when this occurs, the switch or switches in the middle shall utilize two 1310 nm SFP optic modules. Optic modules shall be provided as described in the Project Specifications, 614 – CWDM SFP and 614 – Small Form-Factor Pluggable – 1310 nm SFP as part of this specification package.

The Ethernet switches shall interface with the existing Ciena 5150 Ethernet aggregation switches located in either a regeneration node building or the CTMC.

A single mode, 9/125um CWDM wavelength independent attenuator to match the wavelength of the SFP optic modules shall be included and installed in the communications cabinet termination patch panel. Optical attenuators shall be provided as described in the Project Specification, 614 - Coarse Wavelength Division Multiplexing Attenuator.

MATERIALS

The Ethernet switch shall be configured with two (2) 1GIG/10GIG SFP ports, four (4) 100M/1000M SFP ports and two (2) 100/1000M RJ-45 Ethernet ports. User Network Interface (UNI) ports are not required as part of the Ethernet switch.

The Contractor shall furnish and install the Ethernet switch and associated items shown in Item Table A below. The Contractor shall also furnish the Ethernet switch software and maintenance licenses show in Item Tables B and C. Tables A, B and C describe items for a single Ciena 3930 SDS Ethernet switch.

Item Table A – Ciena 3930 SDS Ethernet Switch, Typical Hardware Description

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
3930, (4) 100/1000M SFP, (2) 100/1000M RJ-45, (2) 1G/10G SFP+, EXT.TEMP, (2)SLOTS AC/DC POWER SUPPLY	170-3930-900	1
3930, AC PLUGGABLE POWER SUPPLY, WIDE RANGE 120/240V	170-0014-900	2
AC POWER CORD, IEC C15, 10 FT, OUTDOOR, NORTH AMERICA	170-0019-902	2
3930 19 INCH RACK MOUNT EARS, FOR USE WITH 1 RU CHASSIS	170-0602-903	2
10-LAMBDA CWDM MUX/DEMUX W/EXPANSION PORT, 2-SLOT LGX RACK MODULE, LC/APC CONNECTORS, MONITOR PORT (refer to 614 – CWDM Module) (for existing Ciena 5150 switches)	CWDM-EMUX10M	AS REQUIRED
12-SLOT LGX MOUNTING PANEL W/INTEGRATED FIBER MANAGEMENT, 4RU (refer to 614 – CWDM Module) (for existing Ciena 5150 switches)	CWDM-PAN012	AS REQUIRED
10/100/1000M, SFP TRANSCEIVER, RJ45 CONNECTOR, SGMII, 100 METERS, EXTENDED TEMPERATURE	XCR-B00CRJ	2
100M/1GIG, SM SFP OPTIC, LC CONNECTOR, 10 KM, 1310 NM, EXTENDED TEMPERATURE (refer to 614 – Small Form-factor Pluggable SFP)	XCVR-A10Y31	AS REQUIRED
100M/1GIG, SM SFP OPTIC, LC CONNECTOR, 40 KM, 1310 NM, EXTENDED TEMPERATUR (refer to 614 – Small Form-factor Pluggable SFP)	XCVR-A40Y31	AS REQUIRED
100M/1GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1**xx**0 NM,EXTENDED TEMPERATURE (refer to 614 – CWDM SFP) (for Ciena 3930 and existing Ciena 5150 switches)	XCVR-A80D**xx**	AS REQUIRED

xx – values range from 43 to 61 based on required CWDM wavelengths (1430 nm to 1610 nm)

Item Table B – Ciena 3930 SDS Ethernet Switch, Typical Software Description

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
SAOS ADVANCED ETHERNET PERPETUAL SOFTWARE LICENCE FOR 3930	S70-0001-900	1
SAOS ADVANCED OAM PERPETUAL SOFTWARE LICENCE FOR 3930	S70-0001-901	1
SAOS ADVANCED SECURITY PERPETUAL SOFTWARE LICENCE FOR USE WITH SAOS 6.X	170-0204-900	1
ESM CARRIER ED RIGHT TO MANAGE PERPETUAL SOFTWARE LICENSE FOR 3930	S70-0005-900	1

Item Table C – Ciena 3930 SDS Ethernet Switch, Typical Maintenance License

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
SMARTSUPPORT, 3930, 3 YEARS	80M-3930-SSP	1
HARDWARE REPAIR SERVACE 10 DAY MAINTENANCE, 3930, 2 YEARS	80M-3930-HWM	1
NEXT BUSINESS DAY MANAGED SPARES, CN 3930, 3 YEARS	80M-3930-NBS	1

Matching CWDM SFP optic modules shall also be provided for existing Ciena 5150 Ethernet aggregation switches in either a regeneration node building or the CTMC to which the Ciena 3930 switches communicate since these Ciena 5150 switches are existing and not purchased as part of this project. In addition to the CWDM SFP optic modules are the required LGX mounting panels and 10-λ CWDM mux/demux rack modules. Quantities for these Ciena 5150 Ethernet aggregation switch CWDM SFP optic modules, LGX mounting panels and 10-λ CWDM mux/demux rack modules are not identified in these material tables because they are dependent on the design of the network.

Each Ethernet Switch shall be furnished and installed with a G.8032 ring protection configuration in conformance with Ciena's Ethernet Design and Configuration Services per the CDOT requirements either prior to installation or at the individual installation sites.

Preliminary configuration including all IP schema design for data transport will be conducted by CDOT personnel prior to installation. All final configurations and G.8032 configuration shall also be conducted by CDOT personnel.

If field changes are made which affect the original Contractor's material order for the Ethernet switches and require any reconfiguration of the original Ethernet switch material orders, the Contractor shall ensure that the Ciena representative is contacted and made aware of such changes to alleviate any possible delays in delivery and installation. If for any reason the switch or associated materials are defective or are damaged at the time of installation by either the

Contractor or by Ciena, the item shall be removed and replaced at no additional cost to the project. Items shall also be replaced if any failures occur due to manufacturer's defects, at no additional cost to the project prior to the final acceptance.

CenturyLink is the direct contracted equipment supplier of Ciena Corporation for the State of Colorado, Colorado Department of Transportation for networking equipment and associated network materials. For project equipment estimate quotations and purchasing, Contractors shall contact the following distributer representative:

Project equipment, equipment estimates, and purchasing distributer representative:

Keith A. Glose

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E-Mail: keith.glose@centurylink.com

Neither CenturyLink nor Ciena Corporation will be involved in the design of the project corridor network. The Contractor shall contact the CenturyLink representative for equipment quotations and purchasing purposes only. The Contractor shall not contact or rely on either CenturyLink or Ciena for network design related questions.

When requesting quotations, the Contractor shall submit to CenturyLink a complete package including the following items:

- A complete list of required equipment for purchase including materials and quantities based on the individual project specifications to achieve a complete item(s) installation.
- A PDF copy of all project specifications pertaining to the material being ordered.
- A PDF copy of all networking project plan sheets.

It is the Contractor's responsibility to provide the distributer's representative all information required pertaining to the complete network design. During the project, CenturyLink or Ciena Corporation is not responsible for any type of network design aide. All questions pertaining to the network design shall be conducted through the Project Engineer for help or clarification.

CONSTRUCTION REQUIREMENTS

The 3930 SDS Ethernet switch will be installed in a communications cabinet or variable message sign and connected via the fiber optic backbone to either a regeneration node building or the CTMC in a protected ring design. Each switch shall normally have both a CWDM SFP optic module and a 1310nm SFP optic module, except as previously noted where there are more than two switches per wavelength. Each switch shall be configured as part of creating a single carrier Ethernet diverse path sub-ring.

For connection of the switch to the optical fiber network, one (1) lateral fiber optic cable shall be terminated and patch cables shall be installed and connected to the optical ports of the switch. A total of four (4) lateral fiber strands shall be used for data communications to the switch. Two (2) lateral fiber strands shall be used for communications connecting the SFP optics carrying CWDM traffic and two (2) lateral fiber strands shall be used for communications connecting the 1310 nm SFP optics, except as noted where there are more than two switches per wavelength.

Additional splicing is required for the CWDM optical filters at each Ciena 3930 location. The CWDM optical filters shall be used to split a single CWDM wavelength from the multiple wavelengths being transmitted along the fiber strands, including passing a 1310 nm wavelength between Ciena 3930 switch pairs. See 614 – Single Wavelength CWDM Optical Filter.

The Contractor shall provide single mode, bend insensitive, pre-connectorized duplex patch cables with a polyurethane jacket for connection from the coarse wavelength division multiplexing SFP optic module and the 1550 nm SFP optic module. Connectors for the patch cable shall be LC on the Ethernet switch end and ST on the termination end. For Ethernet switches in regeneration node buildings or the CTMC, if applicable, proposed termination panels may use LC connectors to accommodate the high termination requirements of the proposed fiber optic cable, accordingly LC-to-LC patch cables could be required at these locations.

The patch cable shall be of sufficient length to span from the termination patch panel to the Ethernet switch SFP ports with a maximum of two (2) feet of slack. They shall be installed in a manner which will not interfere with internal device equipment in the switch enclosure and will include cable management so as not to interfere with future maintenance within the enclosure.

For installations in variable message signs, the Contractor shall install an aluminum backplane on the internal structural supports of the sign housing. It shall be mounted in a location which will not interfere with internal equipment and future maintenance of the variable message sign electronics and cabling. The Ethernet switch shall not be mounted directly on to the variable message sign cabinet wall or sign support.

A field site survey for final placement of the Ethernet switch in the variable message sign cabinet shall be conducted prior to installation.

The Contractor shall arrange to provide for a certified Ciena representative either on site or via remote access through the Colorado Transportation Management Center network to aid in the configuration and installation of the Ethernet switch.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
ETHERNET SWITCH 3931

Section 614 of the Standard Specifications is hereby revised to include the following:

DESCRIPTION

For this project, at locations where installation of a Ciena 3930 Carrier Ethernet Service Delviery Switch (SDS) is infeasible due to the size of the switch, Ethernet Switch shall be a Ciena 3931 Carrier Ethernet SDS integrated in a weather proof enclosure and shall be installed on support posts, in cabinets, or attached to the side of cabinets, to transport Ethernet data to and from roadway ITS devices on this project. All Ethernet switches shall be manufactured by Ciena.

The Ethernet switch shall utilize Coarse Wavelength Division Multiplexing (CWDM) and Small Form-factor Pluggable (SFP) optic modules. Each switch shall be provided with both a CWDM SFP optic module and a 1310 nm SFP optic module where a two switch per wavelength deployment is utilized (typical design). The Contractor is advised that in certain cases there are more than two switches per wavelength and when this occurs, the switch or switches in the middle shall utilize two 1310 nm SFP optic modules. Optic modules shall be provided as described in the Project Specifications, 614 – CWDM SFP and 614 – Small Form-Factor Pluggable – 1310 nm SFP as part of this specification package.

The Ethernet switches shall interface with existing Ciena 5150 Ethernet aggregation switches located in an existing regeneration node building or the CTMC.

A single mode, 9/125um CWDM wavelength independent attenuator to match the wavelength of the SFP optic modules shall be included and installed in the communications cabinet termination patch panel. Optical attenuators shall be provided as described in the Project Specification, 614 - Coarse Wavelength Division Multiplexing Attenuator.

MATERIALS

The Ethernet switch shall be configured with two (2) 1/10GIG SFP+ ports, four (4) 100M/1000M SFP ports and two (2) 10/100/1000M RJ-45 Ethernet ports. User Network Interface (UNI) ports are not required as part of the Ethernet switch.

The Contractor shall furnish and install the Ethernet switch and associated items shown in Item Table A below. The Contractor shall also furnish the Ethernet switch software and maintenance licenses show in Item Tables B and C. Tables A, B and C describe items for a single Ciena 3931 SDS Ethernet switch.

Item Table A – Ciena 3931 SDS Ethernet Switch, Typical Hardware Description

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
3931, PLUGGABLE SYSTEM MODULE, (2) 1/10G SFP+, (4) 100/1000 SFP, (4) 10/100/1000M RJ-45	170-3931-900	1
3931, ENCLOSURE FOR PLUGGABLE SYSTEM MODULE, (2) SLOT AC PLUGGABLE POWER SUPPLY	120-3931-900	1
CABLE ENTRY SEAL, OUTSIDE PLANT FIBER, ½ INCH	170-0074-900	1
CN 3911, (3) BAND CLAMP UAM POLE MOUNT KIT	MISC-BCPM01	1
CN 3911, UAM POLE MOUNT KIT	MISC-MKPM01	1
AC POWER CORD, IEC C15, 10FT, OUTDOOR, NORTH AMERICA	170-0019-902	2
3931, AC PLUGGABLE POWER SUPPLY, WIDE RANGE 120.240V	170-0042-900	2
10/100/1000, SFP TRANSCEIVER, RJ-45 CONNECTOR, SGMII, 100 METERS, EXTENDED TEMPERATURE	XCVR-A00CRJ	2
100M/1GIG, SM SFP OPTIC, LC CONNECTOR, 10 KM, 1310 NM EXTENDED TEMPURATURE	XCVR-A10Y31	AS REQUIRED
100M/1GIG, SM SFP OPTIC, LC CONNECTOR, 80 KM, 1**xx**0 NM EXTENDED TEMPERATURE	XCVR-A80D**xx**	AS REQUIRED

xx – values range from 43 to 61 based on required CWDM wavelengths (1430 nm to 1610 nm)

Item Table B – Ciena 3931 SDS Ethernet Switch, Typical Software Description

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
SAOS ADVANCED ETHERNET PERPETUAL SOFTWARE LICENCE FOR 3931	S70-0006-900	1
SAOS ADVANCED OAM PERPETUAL SOFTWARE LICENCE FOR 3931	S70-0006-901	1
SAOS ADVANCED SECURITY PERPETUAL SOFTWARE LICENCE FOR USE WITH SAOS 6.X	170-0204-900	1
ESM CARRIER ED RIGHT TO MANAGE PERPETUAL SOFTWARE LICENSE FOR 3931	S70-0007-900	1

Item Table C – Ciena 3931 SDS Ethernet Switch, Typical Maintenance License

ITEM DESCRIPTION	ITEM NUMBER	QUANTITY
SMARTSUPPORT, 3931, 3 YEARS	80M-3931-SSP	1
HARDWARE REPAIR SERVACE 10 DAY MAINTENANCE, 3931, 2 YEARS	80M-3931-HWM	1
NEXT BUSINESS DAY MANAGED SPARES, CN 3931, 3 YEARS	80M-3931-NBS	1

Matching CWDM SFP optic modules shall also be provided for existing Ciena 5150 Ethernet aggregation switches in either regeneration node buildings or the CTMC to which the Ciena 3930 switches communicate since these Ciena 5150 switches are existing and not purchased as part of this project. In addition to the CWDM SFP optic modules are the required LGX mounting panels and 10-λ CWDM mux/demux rack modules. Quantities for these Ciena 5150 Ethernet aggregation switch CWDM SFP optic modules, LGX mounting panels and 10-λ CWDM mux/demux rack modules are not identified in these material tables because their use is dependent on the design of the network.

Each Ethernet Switch shall be furnished and installed with a G.8032 ring protection configuration in conformance with Ciena's Ethernet Design and Configuration Services per the CDOT requirements either prior to installation or at the individual installation sites.

Preliminary configuration including all IP schema design for data transport will be conducted by CDOT personnel prior to installation. All final configurations and G.8032 configuration shall also be conducted by CDOT personnel.

If field changes are made which affect the original Contractor's material order for the Ethernet switches and require any reconfiguration of the original Ethernet switch material orders, the Contractor shall ensure that the Ciena representative is contacted and made aware of such changes to alleviate any possible delays in delivery and installation. If for any reason the switch or associated materials are defective or are damaged at the time of installation by either the

Contractor or by Ciena, the item shall be removed and replaced at no additional cost to the project. Items shall also be replaced if any failures occur due to manufacturer's defects, at no additional cost to the project prior to the final acceptance.

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It is the Contractor's responsibility to provide the distributer's representative all information required pertaining to the complete network design. During the project, CenturyLink or Ciena Corporation is not responsible for any type of network design aide. All questions pertaining to the network design shall be conducted through the Project Engineer for help or clarification.

CONSTRUCTION REQUIREMENTS

The 3931 SDS Ethernet switch shall be installed on device support posts and connected via the fiber optic backbone to a communications node building in a protected ring design. Each switch shall normally have both a CWDM SFP optic module and a 1310nm SFP optic module, except as previously noted where there are more than two switches per wavelength. Each switch shall be configured as part of creating a single carrier Ethernet diverse path sub-ring.

For connection of the switch to the optical fiber network, one (1) lateral fiber optic cable shall be terminated and patch cables shall be installed and connected to the optical ports of the switch. A total of four (4) lateral fiber strands shall be used for data communications to the switch. Two (2) lateral fiber strands shall be used for communications connecting the SFP optics carrying CWDM traffic and two (2) lateral fiber strands shall be used for communications connecting the 1310 nm SFP optics, except as noted where there are more than two switches per wavelength.

Additional splicing is required for the CWDM optical filters at each Ciena 3931 location. The CWDM optical filters shall be used to split a single CWDM wavelength from the multiple wavelengths being transmitted along the fiber strands, including passing a 1310 nm wavelength between Ciena 3931 switch pairs. See 614 – Single Wavelength CWDM Optical Filter.

The Contractor shall provide single mode, bend insensitive, pre-connectorized duplex patch cables with a polyurethane jacket for connection from the coarse wavelength division multiplexing SFP optic module and the 1550 nm SFP optic module. Connectors for the patch cable shall be LC on the Ethernet switch end and ST on the termination end. For Ethernet switches in node buildings, if applicable, proposed termination panels may use LC connectors to accommodate the high termination requirements of the proposed fiber optic cable, accordingly LC-to-LC patch cables could be required at these locations.

The patch cable shall be of sufficient length to span from the termination patch panel to the Ethernet switch SFP ports with a maximum of two (2) feet of slack. They shall be installed in a manner which will not interfere with internal device equipment in the switch enclosure and will include cable management so as not to interfere with future maintenance within the enclosure.

Two flexible liquid tight metal conduits shall be installed from the switch enclosure to the underside of the communications cabinet for electrical power cabling, single mode patch cables and Ethernet CAT6 communications cabling.

The Contractor shall arrange to provide for a certified Ciena representative either on site or via remote access through the Colorado Transportation Management Center network to aid in the configuration and installation of the Ethernet switch.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
FIBER OPTIC CABLE (SINGLE MODE)

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing backbone and lateral single mode fiber optic cables.

MATERIALS

All fiber optic cables shall be suitable for outdoor conduit installation.

All fiber optic cable shall have compatible characteristics with other proposed and existing fiber optic cables.

All optical cables furnished on this project shall meet the following fiber optic industry standards:

(1) International Telecommunications Union – Telecommunications Standardization Sector – Recommendation G.652.D
(2) Telecommunications Industry Association (TIA) – 598-D Optical Fiber Cable Color Coding
(3) International Organization for Standardization (ISO) – 9001
(4) Rural Utilities Service (RUS) – Specification for filled fiber optic cables

All cables shall be new and unused non-armored outdoor cable consisting of non-dispersion shifted, low water peak single-mode fiber strands free of surface imperfections and inclusions. Each single mode fiber strand shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be of matched clad design.

(a) Fiber Strands

Fiber strands shall meet the following minimum characteristics:

(1) Typical core diameter of 9.0µm ± 1 µm
(2) Cladding Diameter of 125 µm ± 1 µm
(3) Core concentricity error: ≤ 0.6 µm
(4) Cladding Noncircularity: ≤ 1.0 %
(5) Coating Diameter (Colored): 245 ± 5 µm.
(6) Maximum Attenuation (Loose Tube): 0.35 dB//km at 1310 nm wavelength and 0.22 dB/km at 1550 nm wavelength
(7) Mode-Field Diameter: 9.20 ± 0.30 µm at 1310 nm wavelength and 10.40 ± 0.50 µm at 1550 nm wavelength
(8) Attenuation at the Water Peak: 0.32 to 0.34 dB/km at 1383 ± 3 nm wavelength
(9) Cutoff Wavelength: ≤ 1260 nm
(10) Zero Dispersion Wavelength: 1300 nm to 1324 nm
(11) Zero Dispersion Slope: ≤ 0.092 ps / ($nm^2 * km$)
(12) Polarization Mode Dispersion: ≤ 0.06 ps/ $\sqrt{km}$

(13) Maximum Polarization Mode Dispersion at 0.01% distribution (PMDq): 0.20 ps/$\sqrt{km}$
(14) Maximum Fiber Dispersion: ≤ 18 ps/(nm * km) at 1550 nm
(15) Fiber Curl: $\geq$ 4.0 m
(16) Proof Tensile Test: 100 kpsi (0.69 GN/m^2)

The fibers shall not adhere to the inside of the buffer tube.

The coating shall be a dual layered, UV cured acrylate applied by the fiber manufacturer. The coating shall be capable of being mechanically stripped with a force of 0.3 to 2.0 lbf.

Each single mode fiber strand shall be color coded with distinct and recognizable colors in accordance with the TIA-598-D *Optical Fiber Cable Color Coding*.

(b) Buffer Tubes

Each backbone buffer tube shall contain 12 fiber strands and each lateral fiber cable shall have two buffer tubes with six fiber strands in each.

Optical fibers shall be placed inside a loose buffer tube.

Each buffer tube shall be color coded with distinct and recognizable colors in accordance with TIA-598-D.

If fillers are required, they shall be placed in the inner layer of the fiber optic cable. The color sequences of the buffer tubes shall begin from the inside layer of and progress outward.

Buffer tube black stripe shall be inlaid in the buffer tube material by means of co-extrusion when required.

In buffer tubes containing multiple fibers, the coloring shall be stable during temperature cycling and shall not be subjected to fading or smearing onto each other or into the buffer tube gel filling material if the fiber cable is supplied with gel filling for water blocking. Colorings shall not cause fibers to stick together.

Each buffer tube shall contain water blocking swellable yarns to prevent water from entering the individual buffer tubes. Swellable water blocking material shall be non-nutritive to fungus, electrically non-conductive and homogeneous. It shall be free from dirt and foreign matter and not require cleaning prior to splicing and placement into the splice closure tray. All fiber strands shall be thoroughly cleaned prior to fiber splicing. All water blocking material shall be uniformly distributed throughout the buffer tubes.

Buffer tubes shall be stranded around a central member of the cable using a reverse oscillation stranding process.

The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of Code of Federal Regulations (CFR) 7 CFR 1755.900 – *RUS Specification for filled fiber optic cables*.

(c) Fiber Cable

Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed and shall not be placed to interrupt the consecutive positioning of the buffer tubes. Fillers shall nominally match the outer diameter of fiber filled buffer tubes.

The central anti-buckling member of the cable shall consist of all dielectric, glass reinforced plastic (GRP) rod.

For single layer cables, a water swellable, (blocking) tape shall be applied longitudinally around the outside of the buffer tubes and fillers. The tape shall be held in place by a single polyester binder yarn. The water swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter. Water blocking material shall be applied uniformly throughout the fiber cable to inhibit the ingress of water into the cable. Gel filled water-blocking compound shall not be allowed in the cable core interstices of the fiber optic cables.

When the fiber cable is provided with dual layer buffer tubes, both the inner and outer layer shall be provided with water swellable tape.

Binders shall be applied with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound), and dielectric with low shrinkage.

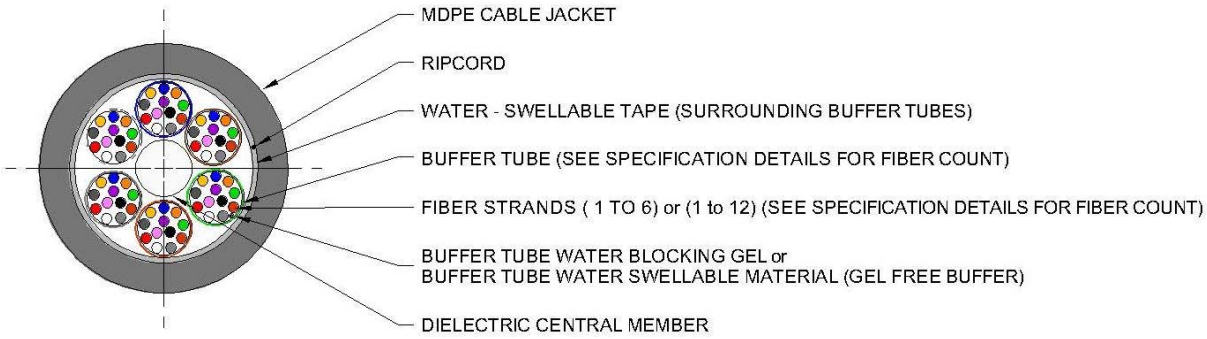
The cable shall contain at least one ripcord under the sheath for easy sheath removal.

Outer cable jacket shall have a consistent thickness throughout the entire cable length and shall be sheathed with medium density polyethylene (MDPE). Jacketing material shall be applied directly over the tensile strength members and water blocking tape. The MDPE jacket material shall be as defined by ASTM D1248, Type II, Class, Category 4 and Grades J4, E7 and E8 and shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The cable jacket shall be free of holes, splits and blisters and be of a consistent thickness.

Cable jackets shall be marked with the manufacturer's name, sequential foot markings, fiber type and count, month and year of manufacture and a telecommunication handset symbol, as required by Section 350G of the National Electrical Safety Code (NESC). The actual length of the cable shall be within 0 to 1 percent of the length markings. The marking shall be in contrasting color to the cable jacket. The height of the marking shall be easily readable.

The Contractor shall submit to the Project Engineer a detailed fiber optic cable specification sheet from the manufacturer for approval. The specification sheet shall be highlighted describing the water blocking material used for both the cable interstices and buffer tubes. Failure to fully describe the type of water blocking material shall result in the submittal being rejected and resubmitted with all highlighted information.



Specification Detail 1

Typical Cross Section of Fiber Optic Cable to Be Provided Per This Specification

(d) Environmental Parameters

The following minimum environmental parameters shall be met:

(1) Shipping, storage and operating temperature range of the cable shall be -40°F to +158°F (-40°C to +70°C)
(2) Operating temperature range of the cable shall be -40°F to +158°F (-40°C to +70°C)
(3) Installation temperature range of the cable shall be -22°F to +140°F (-30°C to +60°C)

(e) Quality Assurance

The following minimum quality assurance requirements shall be met:

(1) All optical fibers shall be 100 percent attenuation tested in accordance with Revision of Section 614 – Test Fiber Optic Cable. The attenuation of each fiber shall be provided with each cable reel.
(2) The cable manufacturer shall be ISO 9001or TL 9000 registered.

(f) Packaging

The following minimum packaging parameters shall be met:

(1) The complete cable shall be packaged for shipment on non-returnable wooden reels.
(2) Top and bottom ends of the cable shall be available for testing.
(3) Both ends of the cable shall be sealed to prevent the ingress of moisture.
(4) Each reel shall have a weatherproof reel tag attached identifying the reel and cable.
(5) Each cable shall be accompanied by a cable data sheet that contains significant information on the cable.
(6) The cable reels shall not be stored nor shipped on their sides.

CONSTRUCTION REQUIREMENTS

Fiber optic cable shall be used for either main backbone cable or lateral cables that connect to communications cabinets. The main backbone cable shall be terminated in a traffic management system building or network facility. Splicing shall be conducted at cable end splice locations and device splice locations as approved by the Project Engineer.

A minimum of one week prior to fiber optic work, the Contractor shall give the Project Engineer a detailed installation and splicing Method Statement and schedule. All installation, splicing, termination, and testing shall be listed on the schedule and Method Statement and revisions shall be re-submitted to the Project Engineer immediately. Installation of the fiber optic cable shall not be permitted until the Method Statement and schedule has been approved by the Engineer.

The Contractor shall be responsible for coordinating with third parties when installing and splicing proposed fiber optic cable adjacent to existing third party owned fiber optic infrastructure and when splicing proposed fiber optic cable to existing third party owned fiber optic cable. The Contractor shall keep the Project Engineer apprised of all coordination activities it performs with third parties as it pertains to this project.

The Contractor shall conform to the requirements included in the Revision of Section 614 - Test Fiber Optic Cable specification, as well as the project specific Testing & Integration Plan.

The Contractor shall provide the Engineer with two copies of the cable manufacturer's installation instructions for all fiber optic cable. All installations shall be in accordance with the manufacturer's recommendations except as otherwise directed by the Engineer. All additional costs including fiber optic cable associated to damages caused by the Contractor's neglect of recommended procedures shall be the Contractor's responsibility.

Fiber optic cable including both backbone cables and lateral cables shall be installed in continuous runs. The Contractor shall include a detailed installation plan with the Method Statement showing cable installation lengths and cable end splice points. The fiber cable shall be installed in reel lengths that minimize the quantity of cable end splices. Under no conditions shall fiber optic cable be cut or spliced at intermediate points without express written direction from the Engineer.

The new fiber cable shall be installed in a manner which will not interfere with the integrity of existing cable and equipment and shall be installed in a manner which will not interfere with the maintenance of the traffic signal cable, wiring, or equipment.

Blowing cable is an acceptable alternative to pulling cable. If the Contractor chooses to use this method, submittals for cable installation shall be submitted along with complete information on fiber installation equipment.

The maximum pulling tension shall be 600 pounds (2700 N) during installation (short term) and 200 pounds (890 N) long term installed.

All cables shall have a minimum bending radius based on the diameter of the cable and shall meet the following;

(1) Under max pulling tension – 15 (Fifteen times the cable outside diameter)
(2) Unloaded, not under tension – 10 (Ten times the cable outside diameter)

The fiber optic cable shall be installed in the conduit with a split-mesh cable grip to provide a firm hold on the exterior covering of the cable.

The manufacturer's recommended maximum allowable pull tension for cable pull lengths shall not be exceeded. The Contractor shall use a pulley system with a numerical readout indicating the cable tension. The pulley system shall be capable of alerting the installer when the cable pulling tension approaches the manufacturer's maximum allowable tension. The Contractor may supplement this procedure with a breakaway tension limiter set below the lowest recommended tensile limit of the cables being pulled. Intermediate pulleys shall be used at all pull boxes or manholes along the installation run to prevent cable damage.

If cable installation limits are met and the entire length cannot be installed completely from the shipping reel, installation shall be continued from the mid-point of the run. The Contractor shall first pull one-half of the cable from the reel at the mid-point through the conduit to one end of the run. The other half of the cable shall be removed from the reel and carefully placed on the ground in a figure eight pattern with a minimum loop diameter of 10 feet. While installing the remaining cable, care shall be taken to avoid dragging against the ground resulting in damage or excess bending of the cable. The Contractor shall not kink, twist or bend the cable during installation coiling and uncoiling.

The cable shall be continuously lubricated as it enters the conduit. The Contractor shall only use pulling lubricants recommended by the cable manufacturer. Liquid detergent shall not be used.

The Contractor shall furnish and install a pre-lubricated pull tape and tracer wire in the same conduit as the fiber is being installed. The pull tape and tracer wire shall conform with Revision of Section 613 – Electrical Conduit.

If the Contractor must install new cable in conduits that contain existing fiber optic cable or electrical wiring, the Contractor shall be responsible for all damage to the existing cables and wires. After this installation the Contractor shall perform a functional test of all the equipment connected by the existing fiber cables and electrical wiring to ensure proper working conditions. All costs associated with equipment testing and repairs shall be included in the cost of the fiber optic cable.

If an existing fiber optic cable is damaged during construction, it shall be removed from both points of termination and replaced, at no cost to the project.

In no case shall the conduit fill ratio of new conduit exceed the requirements of the National Electrical Code.

Lateral cables shall be installed in continuous runs from the backbone splice location to the communications cabinet. Odd length cables and reel ends are acceptable for lateral cables provided they are pre-tested and free of defects and are of sufficient lengths to archive continuous runs.

Installation of lateral fiber optic cables shall include slack coil and a minimum of three strain relief locations within all communications cabinets and traffic signal cabinets.

All fiber optic cables shall include identification labels attached to the cable in each pull box, manhole or communications cabinet. The information to be included on the label shall be approved by the Engineer.

The Contractor shall coil 50 feet of each fiber cable in pull boxes and 100 feet in manholes.

At locations of Coarse Wavelength Division Multiplexing (CWDM) network equipment, the Contractor shall install and coil two separate 100-foot lateral fiber optic cables in the splice manholes. Refer to the fiber optic splicing details for more information.

Splicing of CWDM lateral fiber cables by the Contractor shall be as shown in the project plans.

Backbone and lateral buffer tubes and fiber strands shall be labeled on the splice tray prior to sealing of the closure. In the CWDM splice closure, the optical filter wavelengths shall also be labeled.

The Contractor shall ensure that all cable coils and splice canisters are attached separately to the cable management hardware inside manholes in a manner which will allow for all splice closures to be removed separately for future maintenance purposes. In Pull Boxes, all cable coils shall be attached separately to the cable management hardware in a manner which will allow for fiber optic cable to be removed separately.

The Contractor shall terminate the lateral cable at the communications cabinet in accordance with the Revision of Section 614 – Fiber Optic Termination Panel.

Prior to performing splicing and testing for CDOT traffic signals, the Contractor shall contact Joseph Pirera, CDOT Traffic Signals & Ramp Metering Supervisor (303-815-9194) to allow for traffic signal technicians to disconnect all existing optical communications equipment.

The Contractor shall submit a final documentation package. The final documentation package shall include the cable manufacturer's installation procedures, technical support documentation and material documentation. These documents shall match the original submittals provided to the Engineer.

At any time, if the Contractor damages any of the fiber optic backbone cables, the entire end-to-end (reel-to-reel) section of fiber cable shall be removed, re-installed, and re-spliced from the cable end splice point at the Contractor's expense.

At any time, if the Contractor damages any of the fiber optic backbone laterals, the entire end-to-end (reel-to-reel) section of fiber cable shall be removed, re-installed, and re-spliced from the splice point to the device communication cabinet at the Contractor's expense.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
FIBER OPTIC PRE-CONNECTORIZED CABLE

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of the installation of fiber optic pre-connectorized patch cables in communication cabinets and communications node buildings from the termination patch panel to the optical communication device optics.

MATERIALS

The measured attenuation of the connector (inclusive of coupler and mated test connector) shall not exceed an average of 0.3 dB for all connectors provided. Any connector found in excess of 0.5 dB shall be rejected. Reflectance shall be less than -40 dB from 14º F to 140º F (-10ºC to +60ºC). The manufacturer shall have a program that periodically tests connectors to ensure that after 1000 re-matings, the attenuation will not change more than 0.2 dB.

The measured insertion loss shall be a maximum of 0.25 dB with a typical loss of 0.15dB. Return loss shall be a maximum of -65 dB (APC) and -55 dB (UPC) with a typical loss of -68 dB (APC) and -58 dB (UPC). The minimum cable bend radius shall be less the 15 mm.

The connector shall be able to withstand an axial pull of 25 lbs. with no physical damage to the connector and no permanent optical degradation more than 0.3 dB.

The pre-connectorized cables shall be provided with pre-connectorized connectors on both ends to match the termination patch panel bulkheads and small form-factor pluggable optic modules of the Ethernet switch. Connectors shall be terminated by the manufacturer.

The connectors shall be nickel-plated with a ceramic ferrule and shall be polished with a physical contact (PC) finish end to reduce reflection.

The cables shall contain the exact number of loose tube fibers and bulkhead connectors to connect from the termination patch panel to the optical modules. If the optical equipment transmits and receives data with a single optic, the pre-connectorized cable shall contain a single optical fiber, (simplex). When the optical device transmits and receives data with two or four optics, or a network Ethernet switch small form factor pluggable optic module, a pre-connectorized cable shall be provided with 2 (two) optical fibers (duplex) per pair of transmit and receive optics.

CONSTRUCTION REQUIREMENTS

Pre-connectorized cables shall be installed from the termination panel bulkheads to the optical modules of the communication devices.

At the communications node building, the pre-connectorized cables shall be installed in the cable management hardware attached to equipment racks. The Contractor shall provide patch cables of sufficient length to span from the fiber termination patch panel bulkheads to the

communications device or network device optical port. This length shall include a maximum of four (4) feet of slack cable. Appropriate cable management shall be used.

At communication cabinets, the Contractor shall provide pre-connectorized cables of sufficient length to span from the fiber termination patch panel bulkheads to the equipment device or network device optical port. This length shall include a maximum of two (2) feet of slack cable. Appropriate cable management shall be used.

Prior to installation, all pre-connectorized cable bulkhead connectors shall be cleaned with lint-free fiber wipes moistened with Isopropyl Alcohol 99% U.S.P. After cleaning with alcohol, the bulkhead shall be cleaned with an optical connector cleaner to ensure that all residue is removed.

Manufacturer testing reports for pre-connectorized cables shall be submitted as part of the as-built documentation. The installation location shall be noted on the test report for future reference.

At communication node buildings, pre-connectorized patch cables shall have identification labels applied on each end. Information indicating the patch panel number, device being connected and Ethernet switch port. CDOT personnel will aid in the labeling as it pertains to the proper nomenclature to be provided and/or Ethernet port connections.

At all field device locations, each cable shall have individual labels indicating the termination panel port and the data transmitting description (example: Tx or Rx).

The pre-connectorized cables shall be provided in the following lengths.

Field Device Cabinets……	4 Feet – 0 Inch maximum
Node Buildings ……	Cable shall be of sufficient length to accommodate connection of termination patch panel bulkhead to each individual optical device while allowing for 4 feet of slack.

REVISION OF SECTION 614
FIBER OPTIC SPLICE CLOSURE

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This item includes installing fiber optic splice closures and performing splicing of both fiber optic backbone and fiber optic lateral cables.

When the project network is designed utilizing Coarse Wavelength Division Multiplexing (CWDM) network equipment, the Contractor shall provide two splice closures. Both closures shall be of the same size and shall be sized to accept both the backbone fiber optic cable and the associated fiber optic lateral cable(s).

The CWDM splicing design shall include one splice closure utilized for splicing of the backbone fiber optic cable to the lateral fiber optic cable(s) and filters. The second splice closure will be used for splicing the lateral fiber optic cable(s) to the coarse wavelength division multiplexing single wavelength filters and the lateral fiber optic cable(s) extending to the device communications cabinet or variable message sign.

MATERIALS

The fiber optic splice closures shall be furnished and installed by the Contractor.

The splice closures shall be dome type and shall meet the following minimum requirements:

(1) The closures shall seal, anchor and protect fiber optic cable splices.
(2) The closures shall have a minimum of six total cable entries.
(3) The closures shall be suitable for underground applications and shall be corrosion resistant, watertight and airtight.
(4) The closure splice trays shall have a hinged design with an upright locking mechanism for all splice trays.
(5) The closures shall have a sealing design that does not require glue, sealant, or new cable seals to re-enter the closure.
(6) The closure shall be bonded inside and outside and have an external ground lug.
(7) The Contractor shall include all necessary accessories to complete splicing.
(8) The Contractor shall include all mounting hardware.
(9) The splice closure shall comply with Telcordia Generic Requirement (GR) GR-771.

The closures shall be sized to provide a capacity equal to the total number of strands for all cables entering the closure.

CONSTUCTION REQUIEMENTS

The Contractor shall notify the Project Engineer of proposed daily splicing locations two business days prior to splicing and also the morning of proposed splicing. The Contractor shall contact the Project Engineer at least four hours prior to sealing the closure to allow inspection.

If the Project Engineer cannot be on site to inspect the open splice closure, a minimum of eight digital pictures shall be taken at varying angles of the interior of the splice closure showing all completed work as stated in this specification. The pictures shall include exposed fiber stands (both spliced and uncut) in all splice trays, fiber tray labeling and remaining buffer tubes showing appropriate coiling. One picture shall also include the complete re-assembly of all interior parts prior to final sealing. Once the closure and fiber coils are installed in the pull box or manhole, two pictures shall be taken showing the final installation of both the closure and the coiled fiber cable attached to the fiber management hardware. All pictures shall be organized per location and shall be submitted to the Project Engineer along with all final testing result documentation.

All splices shall be performed using the fusion splicing method. The fusion splicer shall be calibrated and certified at least once within the previous year from this project. The Contractor shall present all certification documentation to the Project Engineer prior to start of fiber splicing.

The optical fibers shall be fusion spliced and shall meet the requirements in the Revision of Section 614 – Test Fiber Optic Cable special provision and the project specific Testing & Integration Plan.

The Contractor shall label each individual splice and buffer tube in all splice trays.

All unused buffer tubes and fiber strands shall remain uncut. After the fiber cable and proposed buffer tube is prepped for splicing, all fiber strands in the buffer tube shall be thoroughly cleaned. All uncut fiber strands shall be coiled in the tray. Remaining buffer tubes shall be neatly coiled, secured and stored in the storage area within the closure under the splice trays per the manufacturer's recommendations. Buffer tubes proposed for splicing shall be wrapped and secured to the splice tray with ties per the manufacturer's recommendations.

At CWDM splice locations, the completed splices and coarse wavelength division multiplexing single wavelength filters shall be secured in the splice tray foam splice chips per manufacturer's recommendations.

Bare fiber strands shall not be taped to the splice tray.

All fiber optic cables shall be secured and sealed at the closure entrances. All unused cable entries shall be plugged.

If the closure requires re-entry, it shall be conducted per the manufacturer's recommendation for re-entry and resealing. The Contractor shall use caution to prevent damage to the existing fiber strands, splices, CWDM filters, and buffer tubes inside the splice closure. When sealing the closure for a second time, the Contractor shall follow all re-entry requirements of the manufacturer.

The Contractor shall ensure that the fiber optic splice closures and associated fiber cable coils fit adequately within the manhole or pull box splice locations and shall securely mount the splice enclosure to the side of the manhole.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
FIBER OPTIC TERMINATION PANEL

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing fiber optic termination panels in communication cabinets for single mode fiber optic cables.

MATERIALS

All termination panels shall be manufactured using aluminum and shall be finished with powder coat. The termination panels shall accommodate lateral fiber optic cables. All termination panels shall be equipped with six port Straight Tip (ST) type bulkheads and be compliant with the Telcordia Technologies Generic Requirement (GR) GR-326 *Generic Requirements for Single Mode Optical Connectors and Jumper Assemblies, Latest Issue*. The manufacturer shall perform acceptance testing for insertion loss and return loss with the test certification provided with each patch panel.

All termination panels shall have a labeling scheme that is approved by the Engineer.

All termination panels shall be compatible with the fiber optic cable being terminated.

The six port panels shall have hinged doors that provide access to both the fiber fan out and the termination bulkheads. The panel shall be sized to accommodate the entry of the lateral fiber optic cable, fiber fan out, and bulkheads with the access door closed. The fiber optic patch panel shall be suitable for wall mounting. Dimensions shall not exceed 5 inches wide × 6 inches long × 2 inches deep. Each fiber optic patch panel shall include a fiber adapter panel, adapters, field termination and polishing of fiber, strain relief, grommet tape, zip ties and wall mounting bracket. Terminations within the patch panel shall be polished with a physical contact (PC) finish.

24 port termination panels for lateral fiber optic cables shall be provided to accommodate 24 ports. 24 port termination panels shall be compatible with a 19-inch equipment rack. The panels shall be provided with two six port ST type bulkheads. The panel shall be provided with covers for the remaining spaces. The termination panel shall have a slide out interior.

A 144 port termination panel for the backbone fiber optic cable shall be provided at the County Line Node. This fiber optic termination panel shall be 19 inch EIA/ECA-310 compatible for mounting in a rack and be equipped with a see-through latching front cover. It shall be designed around the physical protection requirements of Telcordia GR-63 *Network Equipment Building System (NEBS) Requirements*. It shall utilize aluminum construction per the requirements of ASTM B209 *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate*. The connector style shall be LC (duplex) with an Angled Physical Contact (APC) finish and an optical return loss meeting or exceeding -60 dB. Each fiber optic termination/splice panel shall be loaded to accommodate the termination of all fibers contained within the proposed backbone cable, unless fibers are spliced through and not landed on the termination/splice panel. The termination panel shall have the ability to remove individual bulkheads or a set of bulkheads to access and clean the backside connection for future maintenance or troubleshooting, unless connectors are

factory sealed in a module with a pigtail. Pigtails shall be stranded with single mode fibers and a minimum length of 15 feet for splicing and coiling. Pigtails shall be organized in the optical splice shelf. Buffer tubes, in splice tray, shall be secured with Velcro strips unless stated another method is approved by the manufacturer. Fusion splicing shall be utilized with heat shrink sleeve protectors, therefore the splice tray capacity, splice tray slots for fusion splices and number of splice trays shall be provided to accommodate the number of backbone fiber to pigtail splices along with the size of heat shrink sleeve protectors utilized. One cable clamp shall be provided for each fiber optic termination/splice panel. All hardware shall be installed in accordance with the fiber optic termination panel manufacturer's recommendations. The Contractor shall provide the Engineer with all associated documentation and manuals. The labeling scheme on the panels and fiber optic cables shall comply with TIA-606 and be consistent with CDOT's labeling code.

Bulkheads in all termination panels shall be metal. Plastic bulkheads will not be accepted.

CONSTRUCTION REQUIREMENTS

Six port termination panels for lateral fiber optic cables shall be installed at locations where either existing or proposed equipment does not allow for the installation of a 24 port termination panel.

24 port termination panels shall be installed within communications cabinets and shall be mounted in locations that allow for ease of access and shall not interfere with maintenance of the internal equipment. 24 port termination panels shall be installed in communications cabinet 19 inch equipment racks.

The Contractor shall field terminate ST type bulkhead connectors on the ends of the lateral fiber cable strands and install them on the back side of the termination panel. The terminated connectors shall be nickel-plated with a ceramic ferrule and shall be polished with a physical contact finish.

Instead of field terminating and polishing lateral fiber optic cables, the Contractor may use a single mode fiber pigtail that is factory terminated on six port ST type bulkhead and fusion splice the pigtail to the lateral fiber optic cable. If this method is used, the termination panel shall be sized and configured to accommodate splicing of the pigtail.

The Contractor shall use proper strain relief inside the termination panel for the fiber cable and fiber fan out strands per the manufacturer's recommendations. The use of tape to secure the individual fanned out strands to the bottom of the termination panel shall not be allowed. The Contractor shall allow enough slack in the terminated fiber to allow for opening and closing the termination panel without disturbing the terminated fiber.

All hardware shall be installed in accordance with manufacturer's recommendations.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
GLOBAL POSITIONING SYSTEM (GPS)

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

The Contractor shall provide Global Positioning System (GPS) Coordinate information for all device, conduit, pull box and manhole locations on this project. Coordinates of both proposed and existing devices in the project limits shall be provided.

MATERIALS

Documentation verifying the type of GPS unit being proposed for use and the specifications of the unit shall be provided to the Project Engineer for review prior to data gathering.

CONSTRUCTION REQUIREMENTS

The Contractor shall provide geodetic datum for all roadway devices, conduit, fiber optic pull boxes, and manholes within the project limits. This shall include Intelligent Transportation System devices, communications cabinets, traffic signal controller cabinets, ramp metering cabinets, automated traffic recorder cabinets, conduit, pull boxes, and fiber optic cable running line manholes.

The Contractor shall use a device designed specifically for mapping GPS information to Universal Transverse Mercator (UTM) Zone 13 coordinate system utilizing 1983 North American Datum (NAD83). Cell phones with GPS capabilities shall not be allowed for determining GPS location.

The GPS data shall be expressed in Latitude and Longitude and Universal Transverse Mercator (UTM) Zone 13 utilizing 1983 North American Datum (NAD83). Altitude shall be expresses in meters:

Latitude and Longitude shall be provided in Decimal Degree (DD) format to a precision of six decimal places.

Example - Latitude: _____ Longitude _____ Altitude (m) _____

North American Datum shall be provided in coordinates to a precision of three decimal places.

Example - X(easting) _____ Y(northing) _____ Z (m) _____

For data collection, the Contractor shall use the averaged waypoint. Minimum averaging time at each location shall be two minutes prior to documenting the information.

Accuracy tolerances for data collected by the GPS unit shall be within a maximum of 3 feet.

The Contractor shall completely fill in all information on the forms provided with Revision of Section 614 – ITS As-Built Documentation for submittal to the Project Engineer.

REVISION OF SECTION 614
GROUNDING AND BONDING

Section 614 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

This work consists of grounding and bonding requirements at project locations for all Intelligent Transportation System (ITS) related structures, poles, service pedestals and cabinets. The work covered in this section consists of labor, materials, and services required for a functional and unobtrusive grounding system.

(a) General: Provide comprehensive grounding and bonding for ITS related equipment. CDOT's target resistance to ground value is equal to or less than 10 Ω.

(b) Applicable Documents: Work performed in this section shall comply with the most current edition of the following codes and standards:

1. IEEE 81 – Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System,
2. IEEE C2 – National Electrical Safety Code,
3. NEMA GR 1 – Grounding Rod Electrodes and Grounding Rod Electrode Couplings,
4. NFPA 70 – National Electrical Code,
5. NFPA 70E – Standard for Electrical Safety in the Workplace,
6. NFPA 780 – Standard for the Installation of Lightning Protection Systems,
7. TIA-607 – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises,
8. UL 96 – Lightning Protection Components,
9. UL 96A – Installation Requirements for Lightning Protection Systems, and
10. UL 467 – Grounding and Bonding Equipment.

(c) Identify to the Engineer any conflicts between the requirements of codes/standards development organizations and the specifications for this project.

(d) Submittals:

1. Provide cut-sheets of each type of product proposed for approval by the Engineer prior to commencement of work.
2. Provide a system plan, conductor routing, supports, connectors and ground rods along with connection, mounting and splicing details.

MATERIALS

Components.

1. Grounding electrodes (driven rods): Provide ground rods that meet or exceed the following requirements:

   A. Preferred: Copper-clad steel ground rods (pointed) shall not be less than 0.625 inch diameter and a minimum of eight feet in length. It shall be UL certified and have a minimum plating thickness of 10 mil copper cladding.

   B. Other Alternatives: Other ground rod types, such as chemical ground electrodes, may be considered based on site soil chemistry, adjacent electrically bonded structures, or if the installation must occur in a corrosive area. The Contractor shall obtain written permission from the Engineer prior to using the previously mentioned alternatives.

2. Grounding Electrode Conductor: The grounding electrode conductor shall be solid or stranded copper with a minimum size of #6 AWG, unless otherwise specified. The Contractor shall size the grounding electrode conductor in accordance with Article 250.66 of the NEC. Bare and insulated grounding electrode conductors shall be permitted, as approved by the Engineer. Insulated grounding electrode conductors shall be Type THWN and conform to the requirements of Article 310 of the NEC. Insulated grounding electrode conductors shall utilize a green jacket color. The grounding electrode conductor run shall be installed in one continuous run without a splice or joint, except as permitted in accordance with Article 250.64(C) of the NEC.

   A. For bonding between a cabinet frame and busbar, a braided ground strap shall be utilized. The braided ground strap shall consist of non-insulated tinned copper flat braid wire with a minimum width of 0.5 inches and a thickness of 0.07 inches (based on estimated #6 AWG equivalence).

3. Grounding Connectors: Grounding connectors shall be provided for attachment to grounding electrodes, ground bus and ground lugs. Grounding and bonding connections shall be made by means of a compression connector, a mechanical connector, or an exothermic weld. Mechanical and compression connectors shall have only one conductor installed unless designed or UL-listed for more conductors. Mechanical connections shall only be permitted when a compression or exothermic connection cannot be made.

4. Ground Bus: Provide copper bar stock grounding busbar. The minimum size shall be 0.25 inch thick by 2 inches high by 6 inches wide and positions for five lugs, unless otherwise specified by the Engineer. Hole patterns on the busbar shall accommodate two-hole lugs in accordance with TIA-607 and hole spacing should not be less than 0.75 inch. Busbar must be wall mountable and UL certified. Stand-off brackets shall also be included and brackets shall be manufactured from 300 series stainless steel with stainless steel bolts and lock washers.

CONSTRUCTION REQUIREMENTS

General: Install equipment, materials and devices in accordance with equipment manufacturer's written instructions and in compliance with applicable installation standards.

1. Connections:
   A. Provide exothermically welded connections below grade and in areas exposed to visible moisture.
   B. Provide heavy duty bolted clamped connections, UL listed, above grade and in areas where safety to personnel and structures dictate.
2. Installation:
   A. Install one grounding electrode. Each grounding electrode shall be installed such that at least the entire length is in contact with the soil. Where a rock bottom is encountered, the grounding electrode installation shall conform to the requirements of Article 250.53(G) of the NEC. The grounding electrode system shall be installed within CDOT right-of-way.
   B. Leave top of grounding electrode exposed for testing and for verifying quantities.
   C. Measure the resistance of the installed grounding electrode with respect to the surrounding soil using an earth ground resistance tester.
   D. If the results exceed 10 Ω, install a second grounding electrode a minimum of one electrode length away from the first grounding electrode. The bonding jumper used to connect grounding electrodes shall be installed and sized in accordance with Article 250.53(C) of the NEC.
   E. Measure the resistance of the installed grounding electrode system with respect to the surrounding soil using an earth ground resistance tester.
   F. Record and report results to Engineer in writing. CDOT's target resistance to ground is equal to or less than 10 Ω, however after installing two grounding electrodes, a resistance to ground value equal to or less than 25 Ω will be accepted by CDOT. The Contractor shall be responsible for confirming the resistance to ground requirements with the various manufacturers of the equipment it procures for this project. Where manufacturers have more stringent resistance to ground requirements for operational performance and warranties, the Contractor shall be required to adhere to the manufacturer's requirements for acceptance by CDOT.
   G. In the absence of low resistance soil conditions, the Engineer, at his/her sole discretion, may allow the use of the following: bentonite to fill the ground rod hole; chemical electrodes; or ground enhancement material. The Contractor shall obtain written permission from the Engineer prior to using the previously mentioned materials.
3. Surface Preparation
   A. Ground Bus: An abrasive pad shall be used to remove any dirt, grease, oil and oxidation from the ground bus. A thin coating of antioxidant compound shall be

applied to the connection point on the ground bus. Using stainless steel hardware, the Contractor shall tighten and torque to the value specified for the hardware grade, material and size. Only one lug shall be installed per a two-hole mounting on a bonding surface. Lugs shall not overlap or use the same mounting holes on a bonding surface. Due to thermal cycling anticipated in the field environment, the lock washer shall be substituted with flat washers and a cupped spring washer (i.e., Belleville washer), with the cup against the head of the bolt.

B. Other Surfaces: Clean the surface thoroughly where the grounding lug is to be connected. The grounding surface shall be clean of any paint, dirt, grease, oil, rust and other oxidation. A thin coating of antioxidant compound shall be applied to the connection point on the surface. Using stainless steel or silicon bronze hardware, the Contractor shall tighten and torque to the value specified for the hardware material and size. Lugs shall not overlap or use the same mounting holes on a bonding surface. The lock washer shall be substituted with flat washers and a cupped spring washer, with the cup against the head of the bolt.

C. Ground Attachment to Structures and Poles: The grounding electrode conductor shall be connected to the ground stud on a structure or within a pole using stainless steel nuts and cupped spring washers. The connector type for the grounding electrode conductor shall be a full circle connector sized appropriately for the diameter of the ground stud and the wire gauge of the conductor.

   Where a ground stud does not exist on a structure or within a pole, the Contractor shall install a tapped and threaded hole to accommodate the grounding electrode conductor and screw. The connector type for the grounding electrode conductor shall be a full circle connector sized appropriately for the diameter of the screw and the wire gauge of the conductor. Stainless steel screws and cupped spring washers shall be included.

D. Grounding Connectors: The lug size, configuration and material for compression connectors shall be selected based on the grounding electrode conductor size and fastening conditions. The insulation shall be trimmed back so that the bared grounding electrode conductor is slightly longer than the barrel. After applying an antioxidant compound on the exposed grounding electrode conductor, insert the conductor so that it touches the end of the barrel as viewed through the inspection port. Ensure the grounding electrode conductor remains at the end of the barrel before making the first crimp nearest the tongue end and working toward the conductor with the remaining crimps. The lug manufacturer's instructions shall be followed for the number of crimps and their location on the barrel.

For exothermic welds to the grounding electrode conductor, select the mold and weld metal applicable to the conductor size and lug configuration. Clean and dry (using a torch) the grounding electrode conductor and the mold. Insert the conductor and lug into the mold. Close the handle clamp, lock the mold and then insert the disk into the mold. Pour the weld metal into the mold and apply the starting material over the weld metal and on the lip of the mold. Close the cover and ignite using a flint igniter. After the reaction is complete, wait a minimum of 15 seconds

and then open the mold and remove the finished lug connection. Clean any slag from the finished lug connection.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
ITS SYSTEM AS-BUILT DOCUMENTATION

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

The Contractor shall complete and transmit to the Project Engineer the ITS as-built documentation as part of the final submittals on the project.

MATERIALS

There are no materials requirements associated with this special provision.

CONSTRUCTION REQUIREMENTS

The Contractor shall document the as-built device, communications, and power infrastructure placement and material information. The Contractor shall clearly mark the plan sheets with red ink describing the as-built condition of all elements installed, including all changes made to fiber optic splicing. The as-built markups shall include the following information related to location markers:

(1) Type of location marker installed
(2) Distances between location markers
(3) Distances between pull boxes and manholes to ITS devices
(4) The distance and location to each CDOT utility point of service connection source point which the local utility companies have provided, including electrical power, transformer source, and telephone pedestals.

At the end of the project, the Contractor shall create a legible PDF scan of the marked up as-built drawings, and submit the hard copy and PDF to the Project Engineer.

The Contractor shall complete the following forms included in this special provision:

(1) Form 1411—ITS Device Installation Checklist
(2) ITS As-Built Documentation Form
(3) Fiber Optic Cable As-Built Documentation Form

Prior to filling out forms, the Contractor shall review the forms and instructions and request all necessary clarification from the Project Engineer. Instructions for Form 1411 are included in this special provision.

The Contractor shall request from the Project Engineer electronic copies of the ITS As-Built Documentation Form and the Fiber Optic Cable As-Built Documentation Form. The Contractor shall fill out the electronic forms and provide the completed forms to the Project Engineer. The file name of the electronic forms shall include the form type, the five-digit construction subaccount number, and a description of the installation location.

Form 1411

https://www.codot.gov/library/forms/cdot-1411

COLORADO DEPARTMENT OF TRANSPORTATION

ITS DEVICE INSTALLATION CHECKLIST (one form per device)

Project Engineer:	Installer:	Installation Date:
Engineer Contact #:	Installer Contact #:	

Device Type: ☐ CCTV ☐ VMS ☐ RWIS ☐ TTI ☐ Radar ☐ ATR ☐ Other: _____

Location: Roadway:_____ (Example: I-70) Direction:_____ (E) Crossroad:_____ (Wadsworth) Mile Marker:_____ (181.6)

Latitude:_____ (Example: 39.46532) Longitude: _____ (-104.3621) Altitude (in meters): _____

Manufacturer:	Model #:
Warranty Start:	Warranty Expiration Date:

Warranty Contact Information: _____ (Example: Vendor/Phone Contact)

Maintenance Responsibility: ☐ ITS ☐ Region _____ ☐ HLT ☐ EJT

IF REGION: ☐ Maintenance ☐ Traffic

Travel Time to Device from Golden, CO (To/From): _____ minutes

Equipment Access:_____ (Example: Bucket Truck, Ladder, Ground Level)

Roadway Closure Requirements for Maintenance:_____ (Example: Shoulder, Lane, Not Applicable)

Communications: ☐ Fiber ☐ Radio ☐ CDWH ☐ CDMA ☐ T1 ☐ Dial-Up ☐ Other: _____

Additional Communication Notes:_____ (Example: Phone#, MAC Address, etc.)

Device Purpose: ☐ Regulatory ☐ Safety ☐ Mobility ☐ Data Support ☐ System Support

Pictures: ☐ Inside of Cabinet ☐ From Traveling Direction ☐ From Opposite Travel Direction
☐ Any Physical Conditions That Could Affect Maintenance

Power Provider:	Contact:	Account:
Comm Provider:	Contact:	Account:

☐ Provide Redline as builts set of where Comm and Power Source from device back to provider to ITS Maintenance
(Contact Matt Rickard (303) 512-5634 with ITS Maintenance, with 3 weeks notice, for Acceptance when both Power and Comms are complete)

Additional Notes:

CDOT Form #1411 8/12

FORM 1411 INSTRUCTIONS

The following instructions are provided for information to the Contractor. The Contractor shall direct all questions regarding form 1411 to the Project Engineer.

(a) Project Engineer / Installer / Contact # / Installation Date

Fill in the name (first, last) of the Project Engineer and device Installer and phone numbers for both parties. Fill in the date of installation.

(b) Device Type

Place a check next to the type of device being installed, or fill in the box marked "Other."

(c) Location / Roadway / Direction / Crossroad / Mile Marker

Fill in the name of the major roadway on which the device is installed, the direction of travel on the side of road on which the device is installed, the nearest crossroad, and highway mile marker to the nearest hundredth of a mile. For the direction of travel, odd numbered highways are always considered north-south highways and even numbered highways are always considered east-west highways.

(d) Latitude / Longitude / Altitude

Fill in the latitude, longitude, and altitude using the method described and the precision and accuracy defined in the special provision Revision of Section 614 – Global Positioning System (GPS).

(e) Manufacturer / Model # / Warranty Start / Warranty Expiration Date / Warranty Contact Information

Fill in the manufacturer name, device model number, manufacturer warranty state date, warranty expiration date, and warranty contact information. The warranty contact information shall be the name and telephone number of the party responsible for addressing warranty issues with the device.

(f) Maintenance Responsibility

With input from Project Engineer, check the applicable box to identify the CDOT personnel responsible for maintaining the device. If a specific CDOT region is responsible, define whether region maintenance or traffic group is responsible for maintenance.

(g) Travel Time to Device from Golden, CO

Use a reliable mapping tool to provide an approximate travel time in minutes (assuming no traffic) from 425 Corporate Circle, Golden, Colorado, 80401 to the device location. Google maps, Apple maps, and Bing maps are examples of reliable mapping tools.

Form 1411 Instructions (Continued)

(h) Equipment Access

Briefly describe how maintenance personnel will access both the communications cabinet and device. If the communications cabinet is at ground level and the device requires a bucket truck for access, write "Cabinet ground level, device bucket truck" or something similar.

(i) Roadway Closure Requirements for Maintenance

Describe what portion of the paved roadway is required to be occupied by a maintenance vehicle to access the communication cabinet and device.

(j) Communications / Additional Communication Notes

Check the appropriate box for the type of communications used for the device, or fill in the box marked "Other." Provide additional applicable communications notes.

(k) Device Purpose

With input from the Project Engineer, check the applicable box to identify the purpose of the device.

(l) Pictures

Check that each described picture (at a minimum) has been taken and provided in a digital format to the Project Engineer. Label each picture file with the major street name, mile marker to the nearest hundredth, device type, and brief description of the picture (e.g. cabinet).

(m) Power Provider / Contact / Account

Insert the name of the power service provider, power company contact phone number, and account number for the device service. If no new power service was provided for the device, fill in "NA"

(n) Comm. Provider / Contact / Account

Insert the name of the communications service provider, communications service contact phone number, and account number for the device service. If communications is via CDOT's network, fill in "CDOT".

(o) Provide redline as-builts

Check the box after redline as-builts of power and communications service points are provided as described.

(p) Additional Notes

Fill in additional notes that are relevant to future maintenance operations.

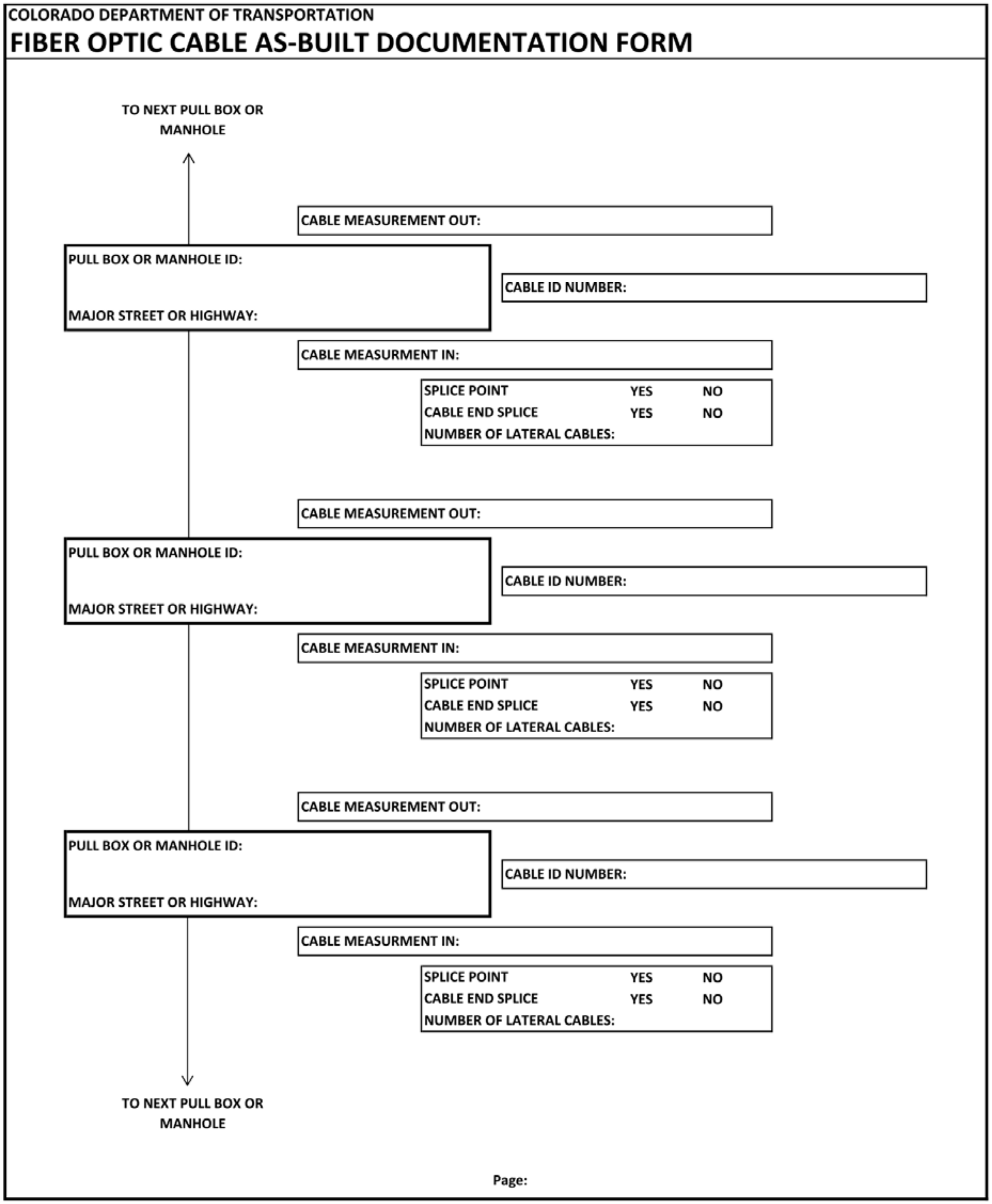
ITS AS-BUILT DOCUMENTATION FORM

COLORADO DEPARTMENT OF TRANSPORTATION

ITS AS-BUILT DOCUMENTATION FORM

Project Engineer:		**Installer:**		**Installation Date:**	
Engineer Contact #:		**Installer Contact #:**			
Fiber					
Cable Size:		**Cable Type:**		**Owner:**	
Cable Manufacturer:		**Cable Length:**			
Fiber Marker Sequential Between Devices:					
Optical Wavelengths to Each Communication Device at the Port Level:					
Patch Panel Size:		**Patch Panel Type:**		**Port Status (Active/Unused):**	
Patch Panel Manufacturer:		**Patch Position (for each fiber):**			
Communication Device					
Type:		**Manufacturer:**			
Configuration:		**Port Type:**			
Fiber Strand Corresponding to Each Active Port:					
Port Wavelength:					
Splice Enclosure					
Splice Enclosure Type:		**Splice Enclosure Manufacturer:**			
Owner:	**Installer:**	**Date Installed:**		**Location Type:**	
Location Description:		**Grounding Method:**			
Site-Specific Comments:					
Electronic Marker					
Marker Type:		**Marker Manufacturer:**			
Marker Color:		**Marker Frequency:**			
Conduit System					
Buried Depth:		**Encasement Type:**			
Manufacturer:		**Model:**		**Measured Length:**	
Length Source:		**Duct Bank Height:**		**Duct Bank Width:**	
Installation Date:		**Material:**		**Construction Status:**	
Duct Availabilty:					

FIBER OPTIC CABLE AS-BUILT DOCUMENTATION FORM


COLORADO DEPARTMENT OF TRANSPORTATION

FIBER OPTIC CABLE AS-BUILT DOCUMENTATION FORM

TO NEXT PULL BOX OR MANHOLE

CABLE MEASUREMENT OUT:

PULL BOX OR MANHOLE ID:

MAJOR STREET OR HIGHWAY:

CABLE ID NUMBER:

CABLE MEASURMENT IN:

SPLICE POINT YES NO

CABLE END SPLICE YES NO

NUMBER OF LATERAL CABLES:

CABLE MEASUREMENT OUT:

PULL BOX OR MANHOLE ID:

MAJOR STREET OR HIGHWAY:

CABLE ID NUMBER:

CABLE MEASURMENT IN:

SPLICE POINT YES NO

CABLE END SPLICE YES NO

NUMBER OF LATERAL CABLES:

CABLE MEASUREMENT OUT:

PULL BOX OR MANHOLE ID:

MAJOR STREET OR HIGHWAY:

CABLE ID NUMBER:

CABLE MEASURMENT IN:

SPLICE POINT YES NO

CABLE END SPLICE YES NO

NUMBER OF LATERAL CABLES:

TO NEXT PULL BOX OR MANHOLE

Page:

REVISION OF SECTION 614
MICROWAVE VEHICLE RADAR DETECTOR (334)

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work shall consist of furnishing and installing microwave vehicle radar detectors in accordance with these Special Provisions at ramp meter locations with ground mounted 334 cabinets. Contractor shall order the Wavetronix SmartSensor HD, configuration software, mounting hardware, and compatible Click! DIN rail mountable components.

MATERIALS
(Pole Mounted Within 40' of Traffic Control Cabinet)

The Microwave Vehicle Radar Detector (MVRD) shall include the radar detector unit, 20' standard combination power/data cable with connector, required length of un-terminated Belden 9330 or approved equal 4 pair separately shielded 22 AWG cable to reach from pole mounted communications cabinet to traffic control cabinet, data line surge suppressor, pole mount hardware, communications cabinet, and configuration software.

The radar detection unit shall be a non-intrusive device using frequency modulated continuous wave radar technology for the gathering of vehicle information including traffic volume, lane occupancy, individual and average speed, vehicle classification, and presence. It shall have auto configuration capabilities to simultaneously identify up to ten highway lanes with the ability to detect over center median barriers and accurately detect partially occluded vehicles. Weather shall not impact the radar detection of the unit. Wind or temperature change shall not cause the device's original field installation configuration to alter over time. The radar detection unit shall include the manufacturer's recommended power/communication cable. The radar detection unit shall meet the following minimum requirements:

(1)	Installation Type:	Side Fire or Forward Fire installation
(2)	Detection Zones:	Up to 10 Lanes Simultaneously
(3)	Detection Range:	3 to 250 feet
(4)	Detection Zone Resolution:	1 foot
(5)	Time Resolution:	2.5 msec
(6)	Elevation 3 dB Beamwidth:	65º
(7)	Azimuth 3 dB Beamwidth:	7º
(8)	Operating Frequency:	24.0 to 24.25 GHz (K-Band)
(9)	Communications:	RS-232 and RS-485
(10)	Power:	8.0 Watts at 9 to 36 Volts DC
(11)	Operating Temperature:	-40 to +165ºF (Ambient)

(12) Humidity: Up to 95% Relative

(13) Shock: 10g 10ms Half Sine Wave

The communications cabinet shall be non-metallic NEMA 4x enclosure or equivalent, measuring 8 inches (H) x 6 inches (W) x 4 inches (D), and have a securable hinged door with weather proof seal to prevent the ingress of wind and water. The communications cabinet shall include an internal backplane with DIN rail and mounting bracket assembly for attachment to supporting pole.

The DIN rail mountable components to be installed inside the communications cabinet shall include a WX-SC-200 Click 200 data line surge suppressor with hot swappable protected busses. The Data Line surge suppressor shall provide protection for RS-232, RS-485, and DC power to the radar detection unit. Wiring for the surge suppressor shall be by means of pluggable screw terminals and include unprotected as well as protected RS-232 and RS-485 communications connectors and shall have a minimum operating temperature range of -29 to 165˚F up to 95 percent relative humidity.

MATERIALS
(mounted inside 334 traffic control cabinet)

There shall be a 19” bent rack mount DIN rail, a DIN rail mountable WX-SC-206 Click 206 .05 Amp re-settable circuit breaker and switch, a DIN rail mountable WX-SC-201 Click 201 AC to DC power converter. The power supply shall accept input voltage from 100 to 240 VAC at 45 to 65 Hz and provide 24 VDC output at 1Amp. The power supply shall have a minimum operating temperature range of -29 to 165˚F up to 95 percent relative humidity. The power supply shall provide for 100 percent power reserve for a minimum of 20 ms to protect against static voltage dips, transient failures of supply voltage, or continuous phase failures. There shall be a WX-SC-205 Click 205 AC lightening power line surge protector DIN rail mountable with hot swappable protected busses, and a WX-SC-200 Click 200 data line surge suppressor. The surge suppressor shall provide protection for RS-232, RS-485, and DC power. Wiring for the surge suppressor shall be by means of pluggable screw terminals and include protected and unprotected RS-232 and RS-485 communications connectors. The surge suppressor shall have a minimum operating temperature range of -29 to 165˚F up to 95 percent relative humidity. The necessary number of input file-mountable WX-SC-174 Click! 174 four-channel and/or WX-SC-172 Click! 172 two-channel contact closure (loop emulator) modules with required RJ-11 patch cords shall be provided to emulate 1 primary and 1 secondary loop for each mainline lane.

CONSTRUCTION REQUIREMENTS

Two conduit access holes, not to exceed 1.5 inches shall be made on the bottom of the communications cabinet. One of these holes is to be used for the power/communications cable in from the sensor and the other for the power/communications cable out to the traffic control cabinet. The access holes shall be positioned at a location to ensure the proper, safe routing of wiring entering the cabinet. 3/4 inch Type 201 stainless steel strap used in conjunction with Type 201 stainless steel buckles shall be used to mount the communications cabinet to the structure so that the top of the cabinet is approximately 5 feet above surrounding grade. The communications cabinet shall be oriented such that anyone working in the cabinet has direct line of sight with oncoming traffic. The Contractor shall be responsible for any necessary modifications or additions needed to mount the communications cabinet to the structure.

0.75 inch Type 201 stainless steel strap used in conjunction with Type 201 stainless steel buckles shall be used to mount the radar detection unit at a height and angle determined by roadway off-set and detection distance in accordance with manufacturer's recommendations and shall be properly grounded per the manufacturer's specifications.

The manufacturer's recommended power/communication cable shall run on the interior of the mounting structure from the radar detection unit to the communications cabinet. A hole not to exceed 1.5 inches shall be made 12 inches below the radar detection unit to allow passage of the power/communications cable into the structure. The Contractor shall ensure strain relief and drip loops in the power/communication cable before the cable enters the structure in accordance with manufacture's recommendations. Two holes not to exceed 1.5 inches shall be made below the communications cabinet to allow the power/communications cables to pass from the interior of the structure to the interior of the communications cabinet. Flexible conduit shall be used to run cables from the structure to the communications cabinet.

The Contractor shall run and connect power from the structure to the 0.5A circuit breaker and power line surge protector in the 334 traffic control cabinet. The Contractor shall wire supply power, power supply, surge suppressors, breaker, and radar detection unit in accordance with the manufacture's recommendations. The radar detection unit shall be wired to support RS-232 serial communications.

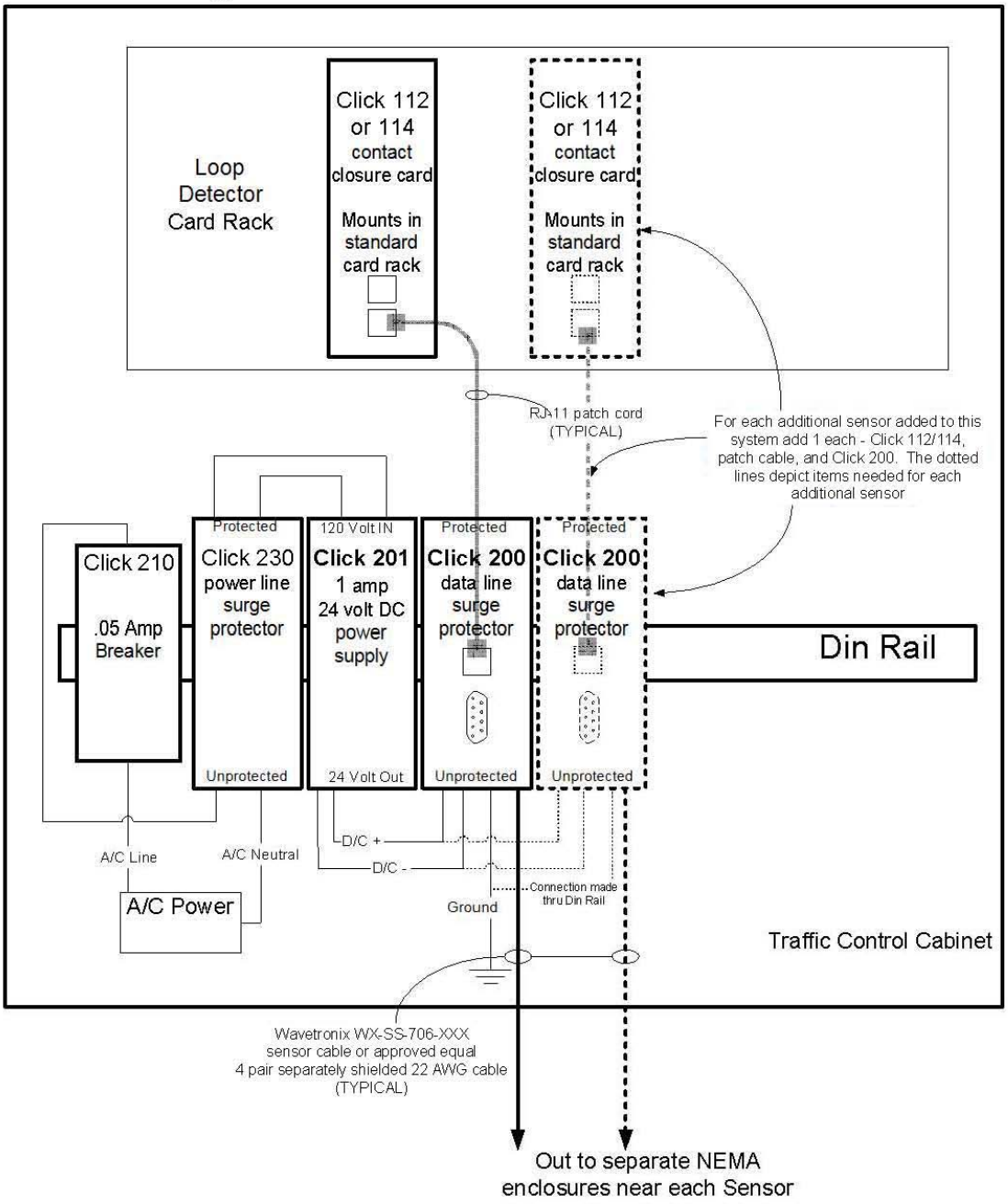
All holes shall be free of burs and sharp edges prior to the installation of all cable, conduit, and conduit nipples. All cable entrances in structures, conduits, and cabinets shall be sealed and waterproofed. All wiring and electrical connections shall be performed in conformance with the latest version of the NEC.

The Contractor shall configure the radar detection unit to detect all lanes, in accordance with the manufacture's recommendations.

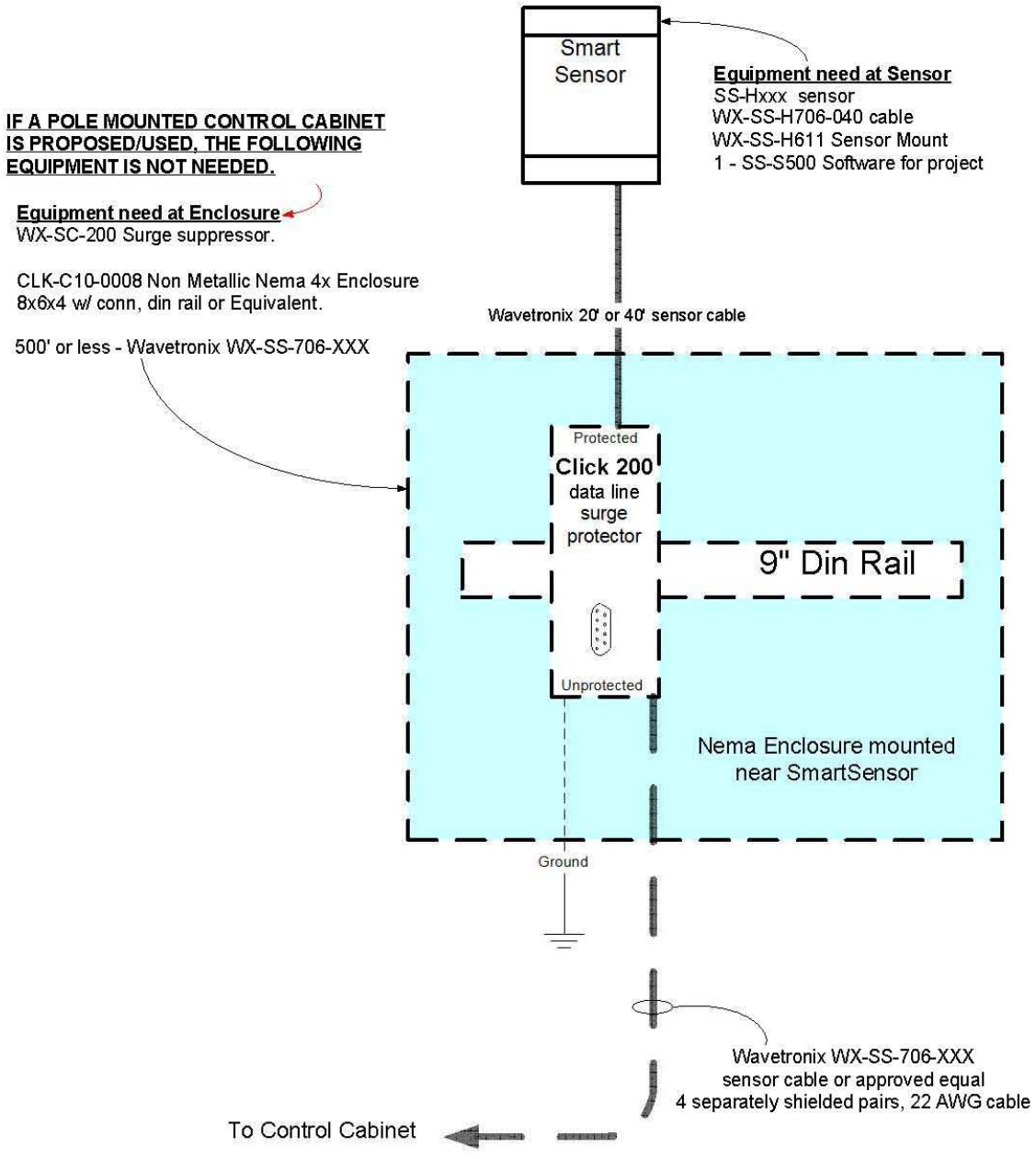
The units shall be environmentally hardened for outdoor use with a temperature range of -10 to +80 degrees centigrade and available in one, two or four RS-232 port units. Also included at this location, a 120 volt AC to 24 volt DC power supply shall be included. This unit shall have a slim line DIN mountable case and be mounted to DIN rail in the 334 traffic control cabinet. The Contractor shall provide units which are compatible with current Department devices installed at various locations.

See project specific Testing & Integration Plan for additional requirements for MVRDs.

Drawing showing the equipment needed in the Control Cabinet when Installing Wavetronix SmartSensors with contact closure.



Equipment drawing for each SmartSensor located less than 500' from control cabinet (as the wire travels).



REVISION OF SECTION 614
MICROWAVE VEHICLE RADAR DETECTOR (NON 334)

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work shall consist of furnishing, installing, and configuring a microwave vehicle radar detector (MVRD) in accordance with these Special Provisions at locations without ground mounted 334 cabinets. Contractor shall order the Wavetronix SmartSensor HD, configuration software, mounting hardware, and compatible Click! DIN rail mountable components.

MATERIALS

The Microwave Vehicle Radar Detector shall include: the radar detection unit with mounting hardware, manufacturer configuration software, detection unit power supply, power and communication cable, serial surge suppression, serial to Internet Protocol (IP) converter, and any additional hardware necessary for a complete and functional installation.

The radar detection unit shall be a Wavetronix SmartSensor HD, model number 101-0415 meeting the following requirements:

The radar detection unit shall include a non-intrusive device using frequency modulated continuous wave radar technology for the gathering of vehicle information including traffic volume, lane occupancy, individual vehicle and average vehicle speed, vehicle classification, and vehicle presence. It shall have auto configuration capabilities to simultaneously identify up to twelve highway lanes with the ability to detect over center median barriers and accurately detect partially occluded vehicles. Weather shall not impact the radar detection functionality of the unit. Wind or temperature change shall not cause the device's original field installation configuration to alter over time. The radar detection unit shall include necessary hardware for pole mounting.

Manufacturer configuration software shall be the latest production version and allow for device discovery, configuration, and troubleshooting.

The power and communication cable shall be the manufacturer's recommended cable for functional operation of the radar detection unit.

A WX-CLK-301 module shall be furnished and installed, along with any cabling, to convert communications from Serial to Ethernet.

The detection unit power supply shall be Wavetronix WX-CLK-201 Deutsches Institut für Normung (DIN) rail mountable hardened alternating current (AC) to direct current (DC) supply meeting the manufacturer's recommendations for functional operation. Power supplies are not required when installed at an intelligent transportation system (ITS) communications cabinet that has existing 12 volt direct current (VDC) power supplies.

Serial surge suppressor shall be Wavetronix Click WX-CLK-200. The surge suppressor shall be DIN rail mountable with hot swappable protected busses. The surge suppressor shall provide protection for RS-232, RS-485, and DC power to the radar detection unit. Wiring for the surge suppressor shall be by means of pluggable screw terminals and include unprotected RS-232 and

RS-485 communications connectors. The surge suppressor shall have a minimum operating temperature range of -30 to 165˚F up to 95 percent relative humidity.

The serial to IP converter shall be an externally powered, hardened, 35 millimeter DIN mountable unit, with one RJ-45 port for connection to an Ethernet network, one screw terminal port for connection to a serial device, and one DB-9M pass through port for local communication. It shall operate in a minimum temperature range of -30 to 165°F at 0 to 90 percent non-condensing humidity. The converter shall be powered externally and run off of 9 to 30 VDC drawing a maximum of 6 watts.

It shall support RS-232, 422, and 485 serial protocols at data rates from 300 to 230 kilobits per second, with hardware and software support for request to send (RTS), clear to send (CTS), data terminal ready (DTR), data set ready (DSR), and data carrier detect (DCD) signal control lines and modem emulation. Power, Ethernet, serial signals, and diagnostic status shall be visible via individual built in light emitting diodes (LEDs).

The converter shall be capable of a 10/100 megabit per second full duplex Ethernet connection. Serial ports shall be accessible via transmission control protocol/IP (TCP/IP), user datagram protocol/IP (UDP/IP), and include software drivers for mapping the ports to Windows, Linux, and Unix operating systems using a secure encrypted connection. It shall be configurable via command line interface through the serial port and integrated web interface via Ethernet connection. It shall be capable of serial bridging across an Ethernet network when two units are used together.

The converter shall support the following protocols: http/https, SNMP, TCP & UDP/IP, ASCII, DHCP, ARP, telnet, reverse telnet, PPP, SSH, SSL/TLS, and AES. The converter shall satisfy underwriters laboratories (UL) 1950, ANSI/ISA 12.12.01-2000 – Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations, and Federal Communications Commission (FCC) part 15 (Class A).

The converter power supply shall be designed for a minimum operating temperature range of -13°F to +158°F at humidity levels of 20 to 95 percent (non-condensing), be DIN rail mountable and meet all manufacturer recommendations. The power supply will not be required at Type 1 and Type 2 communications cabinets where a 12 VDC power supply is provided with the cabinet and there is enough capacity on the supply to power all designated 12 VDC equipment at 80 percent loading.

Additional hardware, including but not limited to the following shall be supplied by the Contractor: mounting hardware, data interconnection cables, and power cables.

CONSTRUCTION REQUIREMENTS

The radar detection unit shall be mounted with 0.75 inch Type 201 stainless steel strap and buckles at a height and angle determined by roadway off-set and detection distance in accordance with manufacturer's recommendations.

The power and communication cable shall run from the radar detection unit through the mounting structure to the communications cabinet. A hole not to exceed 1.5 inches shall be made to allow passage of the power and communications cable into the structure. The hole shall not be made below the centerline of the sensor mount, or more than two feet above the centerline of the sensor mount. The Contractor shall ensure strain relief and drip loops in the power and communication

cable before the cable enters the structure in accordance with manufacture's recommendations, and seal the hole with duct seal. Flexible conduit shall be used to run cables from the structure to the communications cabinet where required. A hole not to exceed 1.5 inches shall be made below the communications cabinet to allow the power and communications cable to pass from the interior of the structure to the interior of the communications cabinet.

All holes shall be free of burs and sharp edges prior to the installation of all cable, conduit, and conduit nipples. All cable entrances in structures, conduits, and cabinets shall be sealed and waterproofed. All wiring and electrical connections shall be performed in conformance with the latest version of the National Electric Code (NEC).

The serial surge suppressor shall be installed on DIN rail inside the communication cabinet. The power and communications cable shall be terminated on the protected side of the WX-SC-200 surge suppression unit per manufacturer's recommendations. The radar detection unit shall be wired to support RS-232 and RS-485 serial communications. Power shall be wired to the manufacturer's recommended power supply or the existing 12 VDC power supply supplied in the communications cabinet. Wiring from the surge suppressor to the communication device shall be stranded Cat5e cable.

The serial to IP converter shall be installed on DIN rail inside the communication cabinet and powered from the manufacturer's approved power supply. When installed in a Type 1 or Type 2 communications cabinet, the 12 VDC power supply provided with the cabinet shall be used instead to power the converter as long as the final total load on the supply is less than 80 percent of total capacity.

The network connection from the converter to the field communication equipment shall be made with Cat5e cable using 8P8C terminations. The cable shall be long enough to connect from the field communication equipment directly to the serial device being converted to allow for future upgrade of the device to direct Ethernet communications.

The serial connection from the converter to the serial surge protector shall be made with stranded Cat5e cable. All bare wire connections shall be cleanly terminated with no stray or loose wires.

The network connection from the converter to the field communication equipment shall be made with Cat5e cable using 8P8C terminations.

The Contractor shall configure the converter with IP addresses as shown on the Plans or provided by the Engineer. Serial communication setting shall also be configured to match the serial device.

For a MVRD the settings are typically: 9600 bits per second, 8N1, no flow control; with TCP connections enabled to the serial port.

The Contractor shall utilize the latest version of manufacturer's software to verify optimal and correct sensor alignment to the roadway and configure the sensor. The Contractor shall configure the radar detection unit to detect all lanes and in accordance with the manufacture's recommendations. The Contractor shall configure the sensor for the following

(1) Sensor Settings
  A) General tab
    1. Subnet/ID=000/Sensor ID per Plans
    2. Location= HWY Installed Direction Mile Post and Common Name
    3. Orientation = Direction the unit is pointing
    4. Date& Time = Synchronize to this computer
  B) Ports tab
    1. Comm: RS-232
    2. Baud Rate=9600 bits per second
  C) Outputs tab
    1. Legacy Protocols
      (a) SS105 Protocol = Off
      (b) RTMS protocol = Off

(2) Lane Setup
  A) Sensor Alignment: Shall show green, unless detected lanes are not parallel.
  B) Lane configuration = Setup using auto-configuration and manually adjust as necessary to detect lanes

(3) Data Setup and Collection
  A) Interval Data: Interval=30 seconds
  B) Data Push = OFF for output to RS-232 port

Once the device has been configured the Contractor shall verify connectivity through the serial to IP converter to the device, and connect the serial or Ethernet connection to the field communication device as appropriate. Once network connectivity have been verified, the Contractor shall confirm that the device is accessible and fully functional from the centralized software system at the CTMC.

See project specific Testing & Integration Plan for additional requirements for MVRDs.

REVISION OF SECTION 614
OPTICAL ATTENUATOR

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

Coarse Wavelength Division Multiplexing Attenuator shall be installed for both CWDM and 1310nm SFP optic modules to reduce optical signal power to a receive level specified for the SFP optic modules based on the transmission loss of the corresponding link. These shall be installed at Ciena 3930/3931 Carrier Ethernet Service Delivery Switch and existing regeneration node building or CTMC Mux/DeMux locations. The attenuator shall be installed in the receive port of the equipment cabinet fiber optic termination patch panel bulkhead or Mux/DeMux. All attenuators shall be compatible with the Ciena CWDM SFP optic modules.

MATERIALS

The Contractor shall furnish and install single mode, 9/125um CWDM wavelength independent attenuators to attenuate the incoming signal to a power acceptable within the Ethernet switch SFP optic module receive range.

For testing and attenuator selection, wavelengths of SFP optic modules on this project are:

1430nm, 1450nm, 1470nm, 1490nm, 1510nm, 1530nm, 1550nm, 1570nm, 1590nm and 1610nm.

Attenuators for 1310nm wavelength SFP optic modules will not be required unless the incoming power exceeds the rated receive power of the SFP optic module, including a design margin of 6 dB (to allow for degradation over the life of the system).

The Contractor shall furnish and install a female to male plug type fiber optic attenuator. The types of fiber optic attenuators to be supplied shall match both the termination patch panel bulkhead port, the Mux/DeMux port and the fiber optic pre-connectorized patch cable connector.

The attenuators shall meet the following minimum specifications:

- Return Loss: Less than or equal to -65dB (APC)
- Attenuation Accuracy: +/-0.5 (1~10) +/-1.0(11~30)
- Polarization Dependent Loss: Less than 0.2dB
- Maximum Optical Input Power: 200mW
- Operating Temp Range: -40~80°C
- Low Polarization Dependent Loss **(**PDL**)**
- Minimum 500 connect/disconnecting tested

The attenuators to be provided shall conform to the requirements of Telcordia Technologies GR-910 *Generic Requirements for Fiber Optic Attenuators*.

CONSTRUCTION REQUIREMENTS

After all splicing and fiber optic testing is completed the Contractor shall test the optical power of the incoming, (Receive) signal at each field Ethernet switch and existing node building location. To obtain the most accurate values of optical power, the testing equipment shall be attached to the SFP optic end of the pre-connectorized patch cable.

Once the optical power has been tested, the Contractor shall install the appropriate attenuator in the receive port to meet the receive values of the SFP optic module, including a design margin of 6 dB (to allow for degradation over the life of the system).

Prior to installation, all attenuators shall be cleaned with lint-free fiber wipes moistened with Isopropyl Alcohol 99% U.S.P. After cleaning with alcohol, the bulkhead shall be cleaned with an optical connector cleaner to ensure that all residues are removed.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
OPTICAL TRANSCEIVER

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

Optical transceivers shall be installed at Intelligent Transportation System device locations for communications from the field device to a regeneration node building or the CTMC.

MATERIALS

Optical transceivers shall be provided and installed by the contractor in matched pairs and shall utilize integrated WDM, (Wavelength Division Multiplexing), optics operating at 1310/1550 nm and capable of transporting simultaneous bi-directional data on one single mode optical fiber. The unit shall support the transmission of duplex RS-232 and RS-422 data interfaces. The unit shall be transparent to data protocols used by various manufactures, providing for universal compatibility for the current system and for future expansion. It shall also require no in-field electrical or optical adjustments or in-line attenuators.

LED indicators shall provide power, data transmit and data receive status for monitoring proper system operation. The unit shall provide automatic re-settable solid-state current limiters and independent voltage regulators on each module to reduce the chance of a single point failure of the system. The module shall be hot swappable in a rack mount system to reduce complete system shut down during maintenance or repair.

Mean time between failures shall be 100,000 hours minimum. The module shall be UL and ULC listed and CE marked. The circuit board shall be UL 94 flame rated and meet all IPC standards. All PC boards shall be designated with part number, PC board number and show appropriate revision number. Housing shall be of all metal construction. All LED indicators and both electrical and mechanical connections shall be identified with silk-screened labels. The module shall have a lifetime warranty.

The Optical Transceiver shall meet the following minimum requirements:

1. Status Indicators
    a. Power: On – Red / Off – Off
    b. Data Transmit: Transmit Data – Green / No Data – Off
    c. Data Receive: Receive Data – Green / No Data – Off
2. Connectors
    a. Optical Fiber Bulkhead: ST
    b. Power: Terminal Block with Screw Clamps
    c. Data: RS 232 DB 25 female
3. Electrical Specifications
    a. Power: 12 Volt DC
    b. Current Protection: Automatic re-settable solid-state current limiters
    c. Voltage Regulation: Solid-state, independent on each board

d. Circuit Board: UL 94 flame rated and meets all IPC standards
e. 19 Inch Rack Mount Card: Shall be hot-swappable

4. Environmental
    a. Operating Temp: –40˚C to +74˚C
    b. Storage Temp: -40˚C to +85˚C
    c. Relative Humidity: 0 percent to 95 percent (Non-Condensing)

CONSTRUCTION REQUIREMENTS

Optical transceivers shall be installed in the manner and locations shown on the plans. A complete installation consists of the transceiver unit, fiber optic pre-connectorized cable, power transformer and wiring transformer power to the unit.

Modular units shall be provided and installed in field communications cabinets. The placement of the unit shall allow provision for cable installation and maintenance per manufacturer's recommendations.

Rack mounted units shall be provided and installed in the devices respective regeneration node building or the CTMC.

Prior to completion of the work, the Contractor shall insure the following has been completed on all optical transceivers.

1. Each field transceiver has been connected to power per the manufacture's recommendations.
2. Each field transceiver is wired properly to the device interface.
3. Each regeneration node building/CTMC transceiver is installed in a compatible transceiver chassis and wired properly to the terminal server.
4. Communications of device data between the field and regeneration building transceiver pairs occurs with no transmitting errors.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
SERIAL TO IP CONVERTER

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing a serial to IP converter at field devices. The serial to IP converter is intended to convert serial communication data to IP for access from an Ethernet communication network.

MATERIALS

The serial to IP converter shall include the converter, power supply, Cat5e cable, and any mounting hardware, cabling, and terminations required for a fully functional installation.

Converter: The type of serial to IP converter used will vary depending on the communication requirements of the end device and corresponding control software. Converter A is required for use with a Variable Message Sign (VMS), Microwave Vehicle Radar Detector (MVRD), Diamond Counter for DTD ATR stations, or Traffic Signal (TS). Converter B is required for use with a Ramp Meter (RM) if it is to be connected to an Ethernet switch.

Converter A: The converter shall be an externally powered, hardened, 35mm DIN mountable unit, with one (1) RJ-45 port for connection to an Ethernet network, one (1) screw terminal port for connection to a serial device, and one (1) DB-9M pass through port for local communication. It shall operate in a minimum temperature range of -30 to 165°F at 0-90% non-condensing humidity. The converter shall be powered externally and run off of 9-30 V DC drawing a maximum of 6W. It shall support RS-232, 422, or 485 serial protocols at data rates from 300 to 230kbps, with hardware and software support for RTS, CTS, DTR, DSR, and DCD signal control lines and modem emulation. Power, Ethernet, serial signals, and diagnostic status shall be visible via individual built in LEDs.

The converter shall be capable of a 10/100Mbps full duplex Ethernet connection. Serial ports shall be accessible via TCP/IP, UDP/IP, and include software drivers for mapping the ports to Windows, Linux, and Unix operating systems using a secure encrypted connection. It shall be configurable via command line interface through the serial port and integrated web interface via Ethernet connection. It shall be capable of serial bridging across an Ethernet network when two units are used together.

The converter shall support the following protocols: http/https, SNMP, TCP & UDP/IP, ASCII, DHCP, ARP, telnet, reverse telnet, PPP, SSH, SSL/TLS, and AES. The converter shall satisfy UL1950, UL 1604 (Class1, Division 4), and FCC part 15 (Class A), and IEC 1004-2.

Converter B: The converter shall be an externally powered, hardened, 35mm DIN mountable unit, with two (2) RJ-45 ports for connection to an Ethernet network, two (2) screw terminal ports for connection to serial devices. It shall operate in a minimum temperature range of -34 to 165°F at 5-95% non-condensing humidity. The converter shall be powered externally and run off of 5-30 V DC drawing a maximum of 2W. It shall support RS-232, 422, or 485 serial protocols at data rates from 300 to 230kbps, with hardware and software support for RTS, CTS, DTR, DSR, and DCD

signal control lines with modem emulation. Ethernet link and activity shall be visible via built in LEDs.

The converter shall be capable of a 10/100Mbps full duplex Ethernet connection with auto MDI/MDI-X, and allow multiple units to be connected together. Serial ports shall be accessible via TCP/IP, UDP/IP, and include software drivers for mapping the ports to Windows, and Linux, operating systems using a secure encrypted connection. It shall be configurable via integrated web interface through the Ethernet connection. It shall be capable of serial bridging across an Ethernet network when two units are used together. Centralized monitoring and management software shall be included for the manufacturer. The converter shall support the following protocols: http, SNMP, TCP & UDP/IP, ASCII, DHCP, ARP, telnet, SSH, SSL/TLS. The converter shall satisfy RoHS2, UL 60950, FCC part 15 (Class A), and NEMA, IEC 1004-2, and TS2.

The converter shall be capable of a 10/100Mbps full duplex Ethernet connection with auto MDI/MDI-X, and allow multiple units to be connected together. Serial ports shall be accessible via TCP/IP, UDP/IP, and include software drivers for mapping the ports to Windows, and Linux, operating systems using a secure encrypted connection. It shall be configurable via integrated web interface through the Ethernet connection. It shall be capable of serial bridging across an Ethernet network when two units are used together. Centralized monitoring and management software shall be included for the manufacturer. The converter shall support the following protocols: http, SNMP, TCP & UDP/IP, ASCII, DHCP, ARP, telnet, SSH, SSL/TLS. The converter shall satisfy RoHS2, UL 60950, FCC part 15 (Class A), and NEMA, IEC 1004-2, and TS2.

Power Supply: The power supply shall output 12 VDC and support an input voltage range of 85-264 VAC and frequency range of 47-63 Hz. It shall have a typical efficiency of at least 76% and typical AC current of 1.6 A at 115 VAC. The 12 VDC power supply shall provide an output voltage of 12 VDC and have a minimum current rating of 6.3 A. It shall support an output current range of 0 to 6.3A (minimum) and have a rated power of 75 W (minimum). It shall have overload protection of 105-150% for its rated output power and overvoltage protection for voltages of 15-16.5 VDC. It shall be designed for a minimum operating temperature range of +14°F to +140°F at humidity levels of 20% to 90% (non-condensing). The 12 VDC power supply shall conform to the following standards: IEC 60068-2-6 Environmental Testing (Vibration) and UL 508 Industrial Control Equipment. It shall be DIN rail mountable, have dimensions not exceeding 5 inches (H) by 2.25 inches (W) by 4 inches (D) and a weight of not more than 1.5 pounds. A 12 AWG AC power cord with NEMA 5-15P shall be included with the power supply.

The power supply will not be required at Type 1 or Type 2 ITS cabinets where a 12 VDC power supply is provided with the cabinet and there is enough capacity on the supply to power all designated 12VDC equipment at 80% loading.

Cat 5e cable. Cable shall be an 8 wire twisted pair cable constructed of 24 AWG stranded copper wires with minimum Category 5e rating. The outer jacket shall be UV resistant PVC insulation designed for outdoor use. Shielded cable shall be used when prescribed by the manufacturer, run through conduit or enclosed structures, and when needed for equipment or electrostatic grounding. Shielded cable shall be terminated with either conductive or non-conductive male 8P8C connectors. Where shielded cable is used as an equipment ground, conductive connectors shall be used on both ends of the cable. Where shielded cable is used as an electrostatic drain, the grounded side of the connection shall be terminated with a conductive connector and the ungrounded side shall be terminated with a non-conductive connector. Unshielded cable shall be used for interconnections within the same cabinet, or where grounding and electromagnetic

interference is not present. Unshielded cable shall be terminated with non-conductive male 8P8C connectors on both ends. All Cat 5e cables used for Ethernet data shall conform to the Telecommunications Industry Association (TIA)-568 *Commercial Building Telecommunications Cabling Standard* and utilize the T568B pin/pair assignments.

CONSTRUCTION REQUIREMENTS

When installed in a Type1 or Type 2 ITS cabinet, the serial to IP converter shall be mounted on DIN rail. The 12 VDC power supply provided with the cabinet shall be used to power the converter as long as the final total load on the supply is less than 80% of total capacity. If an additional power supply is needed to power the converter, it shall be mounted on the DIN rail and plugged into a UPS protected outlet if available.

When installed for a VMS, the converter and power supply shall be mounted on DIN rail within 6ft of the VMS controller. For VMS signs with the controller in a ground cabinet, the converter shall be mounted on DIN rail fastened to the 19 inch cabinet rack rail. For VMS signs with the controller in the sign, the converter shall be mounted on DIN rail and fastened with an L bracket to the structural aluminum C-channel above the fold down tray approximately 5ft above the floor. The power supply for the converter shall be plugged into a UPS protected, non-GFCI outlet designated for electronic loads.

When installed in a ground cabinet for a TS or RM, the converter and power supply shall be mounted on DIN rail fastened to the 19 inch cabinet rack rail. The power supply for the converter shall be plugged into a UPS protected, non-GFCI outlet designated for electronic loads.

Stranded 16 AWG copper wires with red and black insulation should be used to wire DC power from the power supply to the converter.

The network connection from the converter to the field communication equipment shall be made with Cat5e cable using 8P8C terminations. The cable shall be long enough to connect from the field communication equipment directly to the serial device being converted and allow for future upgrade of the device to direct Ethernet communications.

The serial connection from the converter to the serial device shall be made with Cat5e cable using the termination compatible with the serial device. For 170/470 VMS controllers this will be an 8P8C termination. The Contractor shall consult with the serial device manufacturer for correct terminations and wiring. All bare wire connections shall be cleanly terminated with no stray or loose wires.

All communication cabling shall be routed cleanly and use cable tie supports every 2 feet. The cables shall be labeled on both ends indicating the device and port of the individual connection. Labels shall be self-laminating vinyl with black lettering on a white background.

The Contractor shall configure the converter with IP addresses as provided by the Engineer. Serial communication setting shall also be configured to match the serial device. In general this is as follows:

- For a 170/470 VMS controller: 9600bps, 8N1, no flow control; with TCP & UDP connections enabled to the serial port.
- For a MVRD: 9600bps, 8N1, no flow control; with TCP connections enabled to the serial port.

- For a Diamond Counter for DTD ATR Stations: 9600bps, 8N1, no flow control; with TCP connections enabled to the serial port.
- For a TS: 9600bps, 8N1, no flow control; with TCP connections enabled to the serial port.
- For a RM: 9600bps, 8N1, hardware flow control with RTS, CTS, and DCD control lines. Serial port mapping on central software is necessary for remote device communication.

After installation the Contractor shall verify local network communications directly to the converter and to the serial device. Once local communications has been verified, the Contractor shall confirm that the device is accessible and fully functional from the centralized software system on the CDOT network.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
SINGLE WAVELENGTH COARSE WAVELENGTH DIVISION MULTIPLEXING (CWDM) OPTICAL FILTER

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

Single Wavelength Coarse Wavelength Division Multiplexing (CWDM) optical filter shall be manufactured specifically for use in CWDM equipment. It shall be provided and installed at all Ciena 3930/3931 Carrier Ethernet SDS Switch locations. All CWDM single channel filters shall be provided from a manufacturer recommended by Ciena.

MATERIALS

The CWDM optical filter shall have the capability of splitting a single CWDM wavelength from the multiple wavelengths being transmitted along the fiber strands including passing a 1310nm wavelength between Ethernet switch pairs. All remaining wavelengths other than those being added or dropped at the designated location shall be allowed to travel from Ethernet switch to Ethernet switch or existing regeneration node building or the CTMC to Ethernet switch.

The CWDM optical filters shall be provided with industry standard operating ranges of 1430nm to 1610nm to match wavelengths of the Coarse Wavelength Division Multiplexing Small Form-Factor Pluggable optic modules of the Ciena Ethernet switches. The individual filters shall have the following channel center wavelengths: 1430nm, 1450nm, 1470nm, 1490nm, 1510nm, 1530nm, 1550nm, 1570nm, 1590nm and 1610nm.

1310nm wavelength filters shall also be provided.

If for any reason the single wavelength filter is defective or is damaged at the time of installation by the Contractor, the filter shall be removed and replaced at no additional cost to the project. Filters shall also be replaced if failures occur do to manufacture's defect, at no additional cost to the project prior to the final network acceptance.

CenturyLink is the Ciena Corporation qualified equipment supplier for the State of Colorado, Colorado Department of Transportation, Intelligent Transportation Systems for networking equipment and associated network materials.

For project equipment estimate quotations and purchasing, Contractors shall contact the following representative:

Project equipment, equipment estimates, and purchasing distributer representative:

Keith A. Glose

Premier Account Manager

CenturyLink Government

930 15th Street, 4th Floor, Denver, Colorado 80202

Telephone: 303-992-5567 Fax: 720-578-2694

E-Mail: keith.glose@centurylink.com

CONSTRUCTION REQUIREMENTS

The filters shall match the industry standard wavelength of the Ethernet switch's Coarse Wavelength Division Multiplexing Small Form-Factor Pluggable (SFP) optic module and the 1310nm SFP optic module.

The CWDM optical filters shall have three (3) fiber pigtails to be fusion spliced to lateral fiber optic cable strands and secured in the foam splice chips located on the splice tray in the splice closure. The pigtails shall be provided with distinctive buffer tube colors designating "Pass", Reflect" and "Common". If the filter pigtail buffer tubes are all of the similar color, The Contractor shall color code each individual tube for future maintenance.

The filters shall be provided with the optical wavelength printed indelibly on the filter body.

Bare fiber strands shall not be taped to the splice tray.

All splices and optical filter wavelengths shall be labeled on the splice tray.

If for any reason the Contractor installs or splices any single wavelength optical filter in a location which does not match the Ethernet switch coarse wavelength division multiplexing SFP optic modules, the Contractor shall replace the filter and re-splice all fibers at no additional cost to the project.

Prior to splicing of the filters, the Contractor shall submit to the Project Engineer a Microsoft Excel spreadsheet containing the following information:

a) Splice Location for the CWDM and 1310nm filters (manhole milepost).
b) Serial Number of the CWDM and 1310nm filters.
c) Wavelength of the filter.
d) Usage and color of filter pigtails.

Once the spreadsheet has been submitted and approved by the Project Engineer the splicing may begin.

The pigtails of the filters shall be labeled inside the splice closure.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
SMALL FORM-FACTOR PLUGGABLE –SFP

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

For this project the Small Form-Factor Pluggable –SFP shall be a single wavelength SFP optic module for installation in Ciena 3930/3931 switches. All SFP optic modules shall be provided from a manufacturer recommended by Ciena.

MATERIALS

The Contractor shall furnish and install the SFP optic module shown in the item table below. This table describes the optic module for installation in the Ciena 3930/3931 Switches installed on this project.

Item Table – 1310nm SFP Optic Modules for a Ciena 3930/3931 Ethernet SDS Switch.

ITEM DESCRIPTION	ITEM NUMBER
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 10 KM, 1310 NM, EXTENDED TEMPERATURE	XCVR-A10Y31
100M/1 GIG, SM SFP OPTIC, LC CONNECTOR, 40 KM, 1310 NM, EXTENDED TEMPERATURE	XCVR-A40Y31

If for any reason the SFP optic modules are defective or are damaged at the time of installation by either the Contractor or by Ciena, the optic module shall be removed and replaced at no additional cost to the project. SFP optic modules shall also be replaced if any failures occur due to manufacturer's defects, at no additional cost to the project prior to the final network acceptance.

CenturyLink is the Ciena Corporation qualified equipment supplier for the State of Colorado, Colorado Department of Transportation, Intelligent Transportation Systems for networking equipment and associated network materials. For project equipment estimate quotations and purchasing, Contractors shall contact the following representative:

Project equipment, equipment estimates, and purchasing distributer representative:

Keith A. Glose

Premier Account Manager

CenturyLink Government

930 15th Street, 4th Floor, Denver, Colorado 80202

Telephone: 303-992-5567 Fax: 720-578-2694

E-Mail: keith.glose@centurylink.com

Neither CenturyLink nor Ciena Corporation will be involved in the design of the project corridor network. The Contractor shall contact the CenturyLink representative for equipment quotations and purchasing purposes only. The Contractor shall not contact or rely on either CenturyLink or Ciena for network design related questions.

When requesting quotations, the Contractor shall submit to CenturyLink a complete package including the following items:

- A complete list of required equipment for purchase including materials and quantities based on the individual project specifications to achieve a complete item(s) installation.
- A PDF copy of all project specifications pertaining to the material being ordered.
- A PDF copy of all networking project plan sheets.

It is the Contractor's responsibility to provide the distributer's representative all information required pertaining to the complete network design. During the project, CenturyLink or Ciena Corporation is not responsible for any type of network design aide. All questions pertaining to the network design shall be conducted through the Project Engineer for help or clarification.

CONSTRUCTION REQUIREMENTS

For Ciena Carrier Ethernet switch installations, 1310nm SFP optic module shall be installed in each switch for data communications in a CWDM design between 2 adjoining Ethernet switches (and at switches located between two adjoining switches, as applicable).

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
TEST FIBER OPTIC CABLE

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

Test Fiber Optic Cable shall include Optical Time Domain Reflectometer (OTDR) tests, Coarse Wave Division Multiplexor (CWDM) OTDR tests, spectrum analysis of CWDM fiber, and optical power meter tests of all installed fiber and modified existing fiber on the project.

MATERIALS

The Contractor shall use equipment that is calibrated twice per year. A copy of the most recent certificate of calibration and all out-of-tolerance conditions shall be provided to the Project Engineer prior to the initiation of testing activities. The following equipment and information is required to perform fiber optic cable tests:

(1) an OTDR (submit certification to Project Engineer)

(2) A Coarse Wave Division Multiplexor OTDR (submit certification to Project Engineer)

(3) An optical spectrum analyzer (submit certification to Project Engineer)

(4) Optical Power Meter Equipment capable of measuring optical power in dBm (submit certification to Project Engineer)

(5) a launch box (min length – 1000 feet)

(6) a light source at the appropriate wavelength

(7) Test jumpers shall be 3 feet to 12 feet long with connectors that are compatible with the light source and power meter and shall have the same fiber construction as the link segment being tested.

CONSTRUCTION REQUIREMENTS

Prior to splicing and testing on the project the Contractor shall submit a detailed Method Statement to the Project Engineer describing the splicing and testing plan and schedule. Discussion of the Contractor's Device Cutover Plan and a proposed Device Cutover Schedule shall be included in the Method Statement. No fiber optic splicing shall begin until the Method Statement is submitted and approved. If at any time it is determined that work began without an approved Method Statement, or the work is not following the approved Method Statement, an immediate "stop work" order will be issued and work will not resume until the Method Statement has been submitted and approved. Once the splicing and testing begins, the Method Statement shall be updated if necessary to address any changes in the original planned and approved procedures.

The Contractor shall conduct fiber optic testing at the following stages:

(1) Pre-installation testing – bi-directional OTDR test of every fiber on every reel after delivery of the reel

(2) Post installation and pre-splicing test – bi-directional OTDR test of every fiber of every cable after fiber is installed in the ground

(3) Post-splicing tests, pre-CWDM filter splicing tests

i) Optical Power meter test from all fiber terminated in communications cabinets to a network facility for all fiber that is not used for CWDM on the project.
ii) Bi-directional OTDR test of all fiber between termination point in a network facility and cable end and between termination point in a network facility and communications cabinets for fiber that is not used for CWDM on the project
iii) Bi-directional CWDM OTDR test of all fiber between termination point in a network facility and cable end and between termination point in a network facility and communications cabinets for all fiber that is used for CWDM on the project

(4) Post-CWDM filter splicing tests

i) Spectrum analysis of all terminated fiber used for CWDM after filters have been spliced
ii) CWDM-OTDR
iii) Optical Power meter test and documented attenuator values

(5) Re-testing of all stages above if initial test fails and after corrective action is taken

The guidelines for fiber optic cable testing include:

(1) Launch box and test jumpers must be of the same fiber core size and connector type as the cable system: Single mode fiber 9.0μm (nominal) /125 μm

(2) The light source and OTDR must operate within the range of 1310±10 nm and 1550±20 nm single mode nominal wavelength for testing in accordance with Telecommunications Industry Association (TIA) TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.

(3) The power meter and the light source must be set to the same wavelength during testing.

(4) The OTDR and power meter must be calibrated at each of the nominal test wavelengths and traceable to the National Institute for Standards and Technology (NIST) calibration standards.

(5) The calibration of the OTDR and power meter shall conform to the requirements set forth in Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA) TIA/EIA-455-226 Calibration of Optical Time-Domain Reflectometers and TIA-455-231 Calibration of Fiber Optic Power Meters, respectively.

The Contractor shall document jacket length measurements for lateral and backbone cable at each end including splice enclosures and patch panels and at any intermediate splice points.

The Contractor shall document bare fiber slack not accounted for in jacket length.

All system connectors, adapters and jumpers shall be cleaned per manufacturer's instructions before measurements are taken.

At locations of new lateral fiber optic cable installation and at locations that require the re-installation of existing lateral fiber optic cable, the Contractor shall conduct testing from the

termination panel mounted in the communications cabinet to the splicing manhole. The bi-directional test shall be conducted from the termination panel towards the splicing manhole and from the splicing manhole to the communications cabinet termination panel.

Final splicing will not begin until such time that the Contractor submits OTDR test results to the Project Engineer and the Project Engineer reviews the results.

Final OTDR testing from the communications cabinet to the corresponding node building shall be conducted after their splicing work has been completed. All issues with communications related to Contractor installation and workmanship shall be remediated by the Contractor at no additional cost to the project.

A functional test shall be made in which it is shown that each and every part of the system functions as specified or intended herein.

(a) Optical Fiber Cable Testing with OTDR

The Contractor shall perform an OTDR test of all fibers in all tubes on the reel prior to installation of the fiber. The test results shall be supplied to the Project Engineer prior to installation of the cable.

Fiber testing shall be performed on all terminated fibers from patch panel to patch panel and unterminated fibers from end to end. Additionally, mid entry splices into mainline cables require testing of all strands in the mainline cable before and after installation. Testing shall consist of a bi-directional end-to-end OTDR trace.

Loss numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two.

The Contractor shall use an OTDR that is capable of storing traces electronically and shall save each final trace.

The Contractor shall use a test reel of minimum length identified in the Materials section of this Special Provision. The Contractor shall indicate the length of the test reel, in feet, for all test results.

If the fiber designation is not indicated on the trace itself, the Contractor shall provide a cross-reference table between the stored trace file name and the fiber designation.

The Contractor shall record the following information during the test procedure:

(1) Name and contact information of person conducting the test

(2) Type of test equipment used (manufacturer, model, serial number, calibration date and valid certification of calibration)

(3) Date test is being performed

(4) Optical source wavelength and spectral width

(5) Fiber identification

(6) Start and end point locations

(7) Test direction

(8) Launch conditions

(9) Method of calculation for the attenuation or attenuation coefficient

(10) Acceptable link attenuation

(11) Cable manufacturer stated index of refraction for cable being tested

(12) Jacket readings in and out of each splice vault and each pull box

(b) Optical Fiber Cable Testing with Optical Power Meter

The Contractor shall conduct an Optical Power Meter Test of each fiber installed.

Single mode segments shall be tested in one direction at both the 1310 nm and 1550 nm wavelength.

The following information shall be recorded during the test procedure:

(1) Names of personnel conducting the test

(2) Type of test equipment used (manufacturer, model, serial number, calibration date and a valid certification of calibration)

(3) Date test is being performed

(4) Optical source wavelength and spectral width

(5) Fiber identification

(6) Start and end point locations

(7) Test direction

(8) Reference power measurement (when not using a power meter with a Relative Power Measurement Mode)

(9) Measured attenuation of the link segment

(10) Acceptable link attenuation

(c) Acceptable Attenuation Values

The Contractor shall calculate acceptable attenuation values for each fiber tested. These values represent the maximum acceptable test values.

The general attenuation equation for all single mode link segments is as follows:

Acceptable Link Attenuation = Cable Attenuation + Connector Attenuation + Splice Attenuation.

8.3 μm (nominal) Single-mode Attenuation Coefficients:

(1) Cable Attenuation=Cable Length (km) x (0.35 dB/km at1310 nm and 0.22 dB/km at1550 nm)

(2) (No. of Mated Connections x 0.50 dB)

(3) Splice Attenuation = Splices x 0.30 dB

(d) Test Procedures

The single mode Optical Power Meter fiber test shall be conducted in accordance with TIA-526-7.

The single mode OTDR test shall be conducted in accordance with TIA-526-7.

Testing for CWDM single wavelength filters (CWDM filter) shall be conducted in the following manner to ensure that the filter Pass, Reflect and Common pigtails are spliced to proper lateral fiber strands. Testing procedures and CWDM data flow information is included on the plans. Testing shall be conducted for all CWDM wavelengths applicable to each fiber strand used for data communications. CWDM wavelengths on this project are expressed in nanometer (nm) and include 1430 nm, 1450 nm, 1470 nm, 1490 nm, 1510 nm, 1530 nm, 1570 nm, 1590 nm, and 1610 nm. Industry standard wavelengths (e.g. 1430 nm = 1431 nm) shall be observed.

After completion of fiber optic cable installation and prior to the CWDM filter splicing, all backbone cable to lateral cable splices shall be completed in the individual Ethernet switch sub-rings. Required steps shall include:

(1) The backbone end of Lateral Cable 1 shall be spliced to the fiber optic backbone cable in Splice Closure 1. Once this splice is complete no future access to Splice Closure 1 shall be made unless a re-splice is required.

(2) The opposite end of Lateral Cable 1 shall be spliced to itself in Splice Closure 2 in a manner to achieve continuity in the backbone strands from the beginning of the sub-ring (first node building) to the far end of the sub-ring (next node building).

(3) An OTDR test shall be conducted on the sub-ring from building to building to ensure proper splicing of Lateral Cable 1 in Splice Closure 1.

Once the OTDR test is complete the results shall be submitted to the Project Engineer for approval. After approval the splicing of CWDM filters in Splice Closure 2 may begin.

The Contractor shall be required to break the Lateral Cable 1 splices in Splice Closure 2 used in the continuity test and conduct the CWDM filter splicing per the project fiber splice plans. This will include splicing of Lateral Cable 1 and Lateral Cable 2 in Splice Closure 2 and the termination of Lateral Cable 2 in the communications cabinet.

After CWDM filter splicing, the Contractor may use one of the following methods to ensure the proper CWDM filter splicing.

(1) By using a fiber identifier, testing of the incoming signal from either the upstream or downstream CWDM location, the Contractor shall show the Project Engineer that proper CWDM filter pigtail splicing has been achieved.

(2) By using a spectrum analyzer to test the incoming wavelength to ensure proper splicing and wavelength of the CWDM signal.

Once all splicing of the individual sub-ring is complete the Contractor shall conduct the CWDM-OTDR and spectrum analyzer testing and submit the results to the Project Engineer. At the acceptance of these tests, the Contractor shall determine the proper optical attenuator to install in the Receive (RX) ports at both the communications termination panel and the node building

termination panel. After installation one final test of optical power shall be conducted to determine if the proper signal strength is being achieved by the Ethernet switch CWDM optic.

At that point the Colorado Department of Transportation, Colorado Transportation Management Center personnel along with Ciena network engineers will configure the sub-ring into the overall CDOT ITS network. If network communications cannot be achieved, a review of the CWDM testing materials will begin.

(e) Test Acceptance

The Contractor shall demonstrate that the tests result in acceptable attenuation values.

The Contractor, solely at the Contractor's expense, shall re-splice all fusion splices and re-terminate all terminations that have test results exceeding acceptable attenuation values. The Contractor, solely at the Contractor's expense, shall retest all fiber links that have been re-spliced and shall retest all fiber links that have been re-terminated.

The Contractor, solely at the Contractor's expense, shall bring all links not meeting the requirements of this specification into compliance.

(f) Submittals

The Contractor shall submit test result documentation as both a hard copy and electronic copy.

After each reel test, the Contractor shall submit one hard copy of the OTDR trace for every fiber on the reel.

After installation, the Contractor shall submit two hard copies and one electronic copy of the following tests:

(1) Continuity OTDR trace for every spliced fiber which the CWDM optical network will utilize.

(2) OTDR trace for every fiber the high speed DWDM optical network will utilize.

(3) CWDM-OTDR trace for every fiber which the CWDM optical network will utilize.

(4) Spectrum analyzer test results for every fiber which the CWDM optical network will utilize.

(5) OTDR traces and power meter results for all "dark" unused fiber strands in the backbone fiber optic cable from node buildings.

Hard copy traces shall be organized and bound in logical order in an 8 ½ inch x 11 inch hard cover binder.

The Contractor shall submit, after approval of the hard copy traces, electronic copies of all traces (PDF and native file format) and appropriate software, if needed, to allow reading the traces.

The Contractor shall submit one copy of the complete contract Plans, including additional drawings issued as part of all change orders, with all deviations clearly marked in color. Deviations to be noted shall include at a minimum, but not be limited to, the following:

(1) Fiber Splice location

(2) Fiber Splice configuration

(3) Termination layout

After all splicing and fiber optic testing is completed the Contractor shall test the optical power of the incoming, (Receive) signal at each field Ethernet switch and existing node building location. To obtain the most accurate values of optical power, the testing equipment shall be attached to the SFP optic end of the pre-connectorized patch cable.

Once the optical power has been tested, the Contractor shall install the appropriate attenuator in the receive port to meet the receive values of the SFP optic module, including a design margin of 6 dB (to allow for degradation over the life of the system).

REVISION OF SECTION 614
TRAVEL TIME INDICATOR

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work shall consist of furnishing and installing a Travel Time Indicator (TTI) in accordance these Special Provisions and manufacturer's recommendations.

MATERIALS

A Travel Time Indicator system includes: a four channel multi-protocol IDentity 6204 Reader with power supply and communication cable, directional antennas, antenna signal cable and terminations, waterproofing mastic, serial surge suppressor, device configuration software, and all other related mounting hardware, cabling, and adaptors.

Travel Time Indicator shall include:

(1) **IDentity 6204 reader with power supply:**

The TTI reader shall be part number 75-0302-3854-9 6204 - 4-pt ISO C B 10374 ASTMV6 PS111 T21, as manufactured by 3M Company – MVSS, 3M Center, Bldg 235-3A-09, St. Paul, MN 55144-1000, Phone: 1-877-777-3571, Fax: 1-800-591-9293. The Contractor must specify that v3.8 of the init.py script be preinstalled in the reader at the time of order.

(2) **Communication Cable**:

The communication cables shall include the following part numbers based on length required at each site:

20 feet (6 meters), RJ-45 terminated, 3M Part Number: 75-0302-0131-5 HA-060081-48-7FT

7 feet (2 meters), RJ-45 terminated, 3M Part Number: 75-0302-0132-3 HA-060081-48-20FT

(3) **Directional Antenna:**

The antenna shall be Sirit Identity 5100 part number ANTENNA-013-K which includes a mount bracket. One antenna is required per vehicle detection direction and per port.

(4) **Antenna signal cable and terminations**:

a. The antenna signal cable type shall be determined by the cable distance from the reader to the antenna. Signal loss at 900 megahertz (Mhz) must be less than 4 decibels per run. The following outdoor rated cable shall be used.
   i. For runs 100 feet or less – LMR-400.
   ii. For runs from 101 to 155 feet - LMR-600
   iii. For runs from 156 to 230 feet – LMR 900

b. Signal cable shall be terminated with weatherproof male N-type crimp on straight plugs that have the following properties:
   i. Ferrule – Copper with Albaloy plating
   ii. Contact pin – Brass with minimum 15 micrometer gold plating
   iii. Retaining ring – 304 stainless steel
   iv. Gasket – Silicone
   v. Insulator – Teflon
   vi. Shell/Body – Brass with Albaloy plating
   vii. Impedance – 50 ohms
   viii. Insulation resistance – Greater than 5,000 megaohms
   ix. Peak operating Voltage – 1,500 volts

(5) Water-proofing mastic for antennas connections.
(6) Serial surge suppressor shall be Wavetronix Click WX-CLK-200 or equivalent.
(7) Device configuration software shall be provided by the manufacturer.
(8) Mounting hardware, cabling, and adaptors including but not limited to: 0.75 inch Type 201 stainless steel strap with Type 201 stainless steel buckles, liquidtight flexible conduit with compatible connectors.

CONSTRUCTION REQUIREMENTS

The Travel Time Indicator reader shall be mounted inside the communications cabinet allowing room for all communication cable connections. A hook and loop fastening system shall be used to mount the reader to the cabinet for ease of removal.

The power supply shall be mounted to Deutsches Institut für Normung (DIN) rail inside the communications cabinet. All wiring shall conform to the most current version of the National Electric Code (NEC).

The Contractor shall supply and install one-inch type 201 stainless steel strap used in conjunction with type 201 stainless steel buckles shall be used to band the antenna mount to the structure at the mounting height directed by the Engineer per guidance from Matthew Becker at 303-435-8288. The Antenna shall be mounted horizontally polarized using the included stainless hardware. The antenna shall be oriented such that it intersects with the oncoming traffic at a 45 degree angle, and is aimed to the center of lanes detected.

The Contractor shall install flexible conduit from the communication cabinet enclosure to the structure for signal cable and power cable installation if required as shown in the plans. Holes made in mounting structures shall be the minimum size necessary to secure the conduit connectors and shall not exceed 1.5 inches in diameter. All holes shall be free of burs and sharp edges prior to the installation of all cable, conduit, and conduit nipples. All cable entrances in structures, conduits, and enclosures shall be sealed and waterproofed. All wiring and electrical connections shall be performed in conformance with the latest version of the NEC.

The signal cable shall connect radio frequency (RF) input/output channels from the TTI reader to the TTI directional antennas – one cable per antenna. The contractor shall route signal cable through existing structures or through new flexible or rigid polyvinylchloride (PVC) conduit

mounted to existing structures. Each signal cable shall be a continuous cable, with no splices, terminated with male N-type crimp on straight plugs on both ends. Installations that require cable lengths exceeding 100 feet shall utilize lower loss cable as to not exceed 4 decibels of loss per run. All signal cables shall be labeled on both ends with ultraviolet (UV) light resistant colored tape before installation. The same color label shall be used on both ends of one cable and label colors shall not repeat at the same installation site. Labels shall be installed such that they are distinguishable from the ground wire.

The Contractor shall ensure strain relief and drip loops in coaxial antenna cable. The Contractor shall provide full support to all coaxial cable not in conduit and wiring trays. All cable entrances in conduits, conduit entrances in structures and cabinets shall be sealed and waterproofed. Conduit and signal cable shall not enter the top of the communications cabinet that houses the TTI reader. Entering through the bottom of the cabinet is preferred, although side entrances will be permitted. Waterproofing mastic shall be applied at all antennas to signal cable connections following manufacturer's recommendations.

The Contractor shall connect antenna signal cables to the TTI reader such that:

Northbound vehicle detection corresponds to Port 1,

Southbound vehicle detection corresponds to Port 2,

Eastbound vehicle detection corresponds to Port 3, and

Westbound vehicle detection corresponds to Port 4.

RS-232 serial and Ethernet communications from the TTI reader shall terminate on their respective surge suppression device. The connection to serial surge suppressor shall allow access to the reader via laptop computer.

The Contractor shall configure the Travel Time Indicator in accordance with manufacturer's recommendations and the following specifications:

CalTrans Title 21 and ISOC protocols enabled for tag detection with only active antenna channels enabled

Power levels set to the minimum needed for reliable transponder detection.

The unit shall be configured for serial communication with the following:

(1) 19,200 bits per second
(2) 8 data bits
(3) No parity
(4) 1 stop bit
(5) No flow control

TPS script v3.8 shall be configured in the reader per CDOT guidelines with the following:

(1) interval: 60 seconds
(2) Reader ID: as shown on plans
(3) Heartbeat: 10 seconds

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
UNINTERRUPTED POWER SUPPLY

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing a rack mounted Uninterruptible Power Supply (UPS), batteries, transfer switch, disconnect switch, and power connections in a Contractor supplied Model 332 or 332D Communications Cabinet. For toll points, the UPS system shall be capable of running essential control electronics, communications equipment, AVI Antennas, Cameras, transaction beacons, and other miscellaneous toll equipment, for at least 8 hours. The bi-directional toll layout shall also be powered by one UPS system and 332 Cabinet for up to 8 hours. For VTMS, the UPS shall be capable of running essential control electronics, communications equipment, and the electronic message sign for at least 8 hours.

The UPS system shall be designed for a hot swap of components and shall not compromise existing operation of dynamic message signs or variable message signs. The unit shall provide for RS232 communication and contact closures for alarm functions.

MATERIALS

The UPS system shall provide “On-Line” dual conversion control.

The UPS shall be rated per the following:

Input Voltage	85 VAC to 135 VAC line to neutral
Input Frequency	48 to 62 Hz
Output Voltage	120 VAC +/- 3%, 1-Phase, 2 Wire plus Ground,
Output Frequency	60 Hz
Power	VA required for running the toll equipment or VTMS for up to 8 hours.

The unit shall be temperature rated to operate from 0 degree C to +40 degree C.

The UPS system shall be capable of producing simultaneously-fully regenerated, conditioned power with true sine wave and continuous AC outputs with stand by capability.

The unit shall have a re-settable power event counter to record the number of power utility failures, a battery run-time counter, and temperature compensated battery charging.

The UPS System shall be capable of providing continuous, fully conditioned (both voltage and frequency), regulated, sinusoidal (AC) power to selected devices such as controllers, modems, and 5 volt power supplies, and sign face drivers.

Wiring shall comply with national electrical code (NEC) standards and approved wiring methods. Properly rated SO/SJO cords shall be allowed to allow easy replacement of the UPS System.

The interconnect cable shall be protected with abrasion-resistant nylon sheathing.

The UPS shall consist of two major components, the Electronics Module and the Battery System.

A. The Electronics Module shall consist of the following:
   1. True Sine wave, high frequency inverter.
   2. Minimum 3-stage, temperature compensated, battery charger
   3. For connection from the Electronics Module to the Battery System, a dedicated harness shall be provided with quick-release, keyed, circular connectors, and braided nylon sleeving over all conductors.
   4. Local and remote control of UPS functions
   5. Local and remote communications capabilities

B. The Battery System shall consist of the following:
   1. Shall meet the continuous 8 hour requirement to run sign electronics, communication equipment, and half of the sign face with all LEDs illuminated at daytime brightness levels.
   2. The batteries shall be comprised of extreme temperature, deep cycle AGM/VRLA (Absorbed Glass Mat/Valve Regulated Lead Acid) batteries that have been field proven and tested by the U.S. military.
   3. Batteries shall be certified to operate at extreme temperatures from -40°C to +74°C.
   4. The batteries shall be provided with appropriate interconnect wiring and a corrosion-resistant mounting trays and/or brackets appropriate for the location into which they will be installed.
   5. Battery construction shall include heavy-duty, inter-cell connections for low-impedance between cells and heavy-duty plates to withstand shock and vibration.

C. The UPS enclosure shall have forced air Cooling/Ventilation:
   1. The UPS shall be forced air cooled by internally mounted, continuous fans.
   2. Fan power shall be provided from the internal DC supply.
   3. Air intake shall be through the front bottom of the unit, and air exhaust shall be out the rear top of the unit.
   4. Intake and exhaust shall have bird/rodent mesh guard and filtration.
   5. The thermal design, along with all thermal and ambient sensors, shall be coordinated with the protective devices before excessive component or internal cabinet temperatures are exceeded.

The UPS System shall come standard with software, RS232 interface via a DB-9F connector, and Ethernet interface via RJ-45 connector allowing full, interactive, remote computer monitoring and control of the UPS functions. The software shall allow the user to set up all operational parameters either locally or remotely and test the functionality of the unit. The unit shall be capable of sending simple network management protocol (SNMP) alarm traps upon alarm conditions and also be configurable via built in web page interface.

The UPS System Alarm Function Monitoring shall come standard with a DB-9F connector with open collectors (40 V @ 20 mA) indicating:

- Loss of Utility Power
- Inverter Failure
- Low Battery

The UPS System Front Panel Controls shall come standard with Power ON, Cold (DC) Start, Alarm Silence, Battery Test, Bypass Breaker, and DC/Battery Breaker.

Reliability shall be calculated with mean time between failure (MTBF) as 100,000 hours based on component ratings.

CONSTRUCTION REQUIREMENTS

Contractor shall provide detailed design and installation plans for Engineer approval prior to installation. Power feeding the sign shall first terminate in the ground mounted cabinet. Non-UPS power shall pass through the cabinet to power non-UPS loads. Power required for sign backup shall feed through the UPS system. A bypass switch, rated for the designed system, shall be installed to bypass the UPS in the event of UPS failure or for system maintenance. A disconnect switch shall also be installed to disconnect UPS and line power from the sign. The Contractor shall install the DMS UPS output into the DMS power distribution panel per sign manufacture recommendations. Serial and Ethernet cables shall be installed from the UPS system ground cabinet to the sign communication device location. All wiring shall conform to the latest version of the NEC.

The UPS equipment shall include a minimum two year warranty on parts and labor. Batteries shall include a minimum two year pro rated warranty. Vendor shall be responsible for processing warranty repairs.

A repair option shall be available for UPS equipment no longer covered by the warranty period. Repair cost shall include all labor and materials necessary to complete the repair. Vendor shall be responsible for processing non-warranty repairs.

See project specific Testing & Integration Plan for additional requirements.

REVISION OF SECTION 614
VARIABLE MESSAGE SIGN (LED) (OVERHEAD)

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing a Light Emitting Diode Variable Message Sign (LED VMS) and associated equipment cabinets at locations. The sign shall be fully compatible with the mounting hardware and support structure.

MATERIALS

The LED VMS shall be equipped with the ability to display three lines of 18-inch tall characters and shall have a display made up of a full matrix configuration. The sign shall have a 66-70 millimeter pixel pitch. All LEDs shall have a viewing angle of 30 degrees.

(a) The sign shall be 26' wide x 8.5' tall x 4' deep with an allowable variation of (+ / - 7 inches). The sign shall include a power shut off mounted to the sign structure near the controller interface cabinet. The sign shall be capable of operating without any decrease in performance over a temperature range of -34° F to +140° F with a relative humidity of 0 to 99 percent, non-condensing. The sign shall have a minimum design life of 20 years. Certifications:

Prior to start of the installation of the LED VMS the Contractor shall provide the following certifications to the Engineer for review and approval:

(1) Certification showing that the manufacturer of the LED VMS is fully compliant with ISO 9001 as of the bid date for this project. The ISO 9001 Certification shall apply to the facility, and to the design, fabrication, installation, and maintenance of the LED VMS. The facility where this company actually designs and manufactures the LED VMS shall be ISO 9001:2000 certified a minimum of one year prior to the bid date for this project.
(2) Working drawings showing the sign housing and tilting brackets (if tilting brackets are used to achieve the required 3 degree sign face tilt) shall be sealed by an Engineer registered in the State of Colorado and shall be submitted in accordance with subsection 105.02.
(3) Certification showing that welding of the LED VMS housing is in accordance with the American Welding Society (AWS) Standards, ANSI/AWS D1.2-97. The LED VMS manufacturer's welders and welding procedures shall be certified by an ANSI/AWS Certified Welding Inspector to the ANSI/AWS D1.2-97 Structural Welding Code for Aluminum.
(4) Certification that all aluminum face materials have a coating that meets or exceeds the requirements of the American Architectural Manufacturers Association (AAMA) Specifications Publication No. 2605.
(5) Certification that the LEDs were tested and binned in accordance with the CIE Test Method A.

(6) Documentation and information on software as described in Appendix A of this document.
(7) Documentation verifying the VMS is listed by an accredited 3rd party testing organization for conformance to UL48 and UL 1433.
(8) All workmanship shall comply with IPC-A-610C, Class 2 titled "Acceptability of Electronic Assemblies"
(9) Documentation providing proof printed circuit board (PCB) silicon conformal coating conformance to MIL-I-46058C Type SR and IPC-CC-830.
(10) Documentation that the sign's structural integrity is in conformance to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals (Current Edition).
(11) Documentation that the VMS conforms to the Transient Protection and Vibration of the NEMA Standard TS4, Section 2.

(b) Sign Housing:

All component parts shall be easily and readily accessible by a single person for inspection and maintenance. There shall be room for a technician to work. Access shall be made by entering the side of the housing. The housing shall be weather tight, and compliant to the NEMA 3R Standard. The bottom panel of the housing shall have a minimum of four drain holes, with snap-in, drain filter plug inserts.

Any visible manufacturer's logo/trade name/reference on the VMS shall be placed on the bottom side of the access door or back panels of the VMS.

The sign housing shall be capable of withstanding a wind loading of 120 mph without permanent deformation or other damage. The sign housing shall also be designed, stamped and signed by a Professional Engineer licensed in Colorado to withstand current AASHTO specified group loading combinations including: sign weight, repair personnel and equipment, ice and wind loads. It shall also meet strength requirements for truck-induced gusts as specified in NCHRP Report 412.

The LED VMS shall be built with a forward tilt angle of three degrees toward the viewing motorists. The sign housing shall be engineered to withstand snow loading of 40 pounds per square foot, as well as the ability to be mounted in a manner that prevents the buildup of snow and creates a natural means by which snow can run off without impeding flow of traffic. The performance of the sign, including the visibility and legibility of the display, shall not be impaired due to continuous vibration caused by wind, traffic or other factors. The housing shall be designed to accommodate mounting on the rear vertical plane and shall be structurally sufficient to be mounted to the sign support structure.

The sign housing and structural components for the tilting system, if required by design, shall be structurally sufficient to perform under all applicable loading conditions including gravity, wind, traffic, weather, roadway deicers, maintenance, and other environmental factors. Working drawings showing the sign housing shall be submitted in accordance with subsection 105.02. Working drawings shall be sealed and signed by an Engineer registered in the State of Colorado.

All parts shall be made of corrosion resistant materials, such as plastic, stainless steel or aluminum. Painted steel is not acceptable. No self-tapping screws shall be used. The exterior front face surfaces shall be finish coated by a system that meets or exceeds the AAMA Specification No. 2605. The finish shall be matte black. The main body of the sign housing shall be constructed of aluminum with a natural mill finish. All exterior seams shall be continuously welded by an inert gas process, except for the coated fascia material.

Each panel shall have a single polycarbonate sheet attached securely to the inside of the aluminum panel. The polycarbonate sheet shall cover all of the pixel openings. The polycarbonate shall be sealed to prevent water and other elements from entering the VMS. The polycarbonate shall contain UV inhibitors that protect the LED display matrix from the effects of ultraviolet light exposure and prevent premature aging of the polycarbonate itself. The use of a plastic lens system will not meet the requirements and will be cause for rejection. No louvers shall be allowed.

Polycarbonate sheets shall have the following characteristics:

- Tensile Strength, Ultimate: 10,000 PSI
- Tensile Strength, Yield: 9,300 PSI
- Tensile Strain at Break: 125%
- Tensile Modulus: 330,000 PSI
- Flexural Modulus: 330,000 PSI
- Impact Strength, Izod (1/8", notched): 17 ft-lbs/inch of notch
- Rockwell Hardness: M75, R118
- Heat Deflection Temperature Under Load: 264 PSI at 270F and 66 PSI at 288F
- Coefficient of Thermal Expansion: 3.9X10-5 in/in/F
- Specific Heat: 0.30 BTU/lb/F
- Initial Light Transmittance: 85% minimum
- Change in Light Transmittance, 3 years exposure in a Southern latitude: 3%
- Change in Yellowness Index, 3 years exposure in a Southern latitude: less than 5%

LED display modules shall mount to the inside of the VMS front face panels and be accessible from the inside of the sign housing only. No tools shall be needed for removal and replacement of VMS display modules.

The external front face panels shall have the following minimum dimensions: The perimeter panels shall be a minimum of 12 inches wide. The external front face panels shall be thermally insulated from the rest of the sign housing. The glazing, aluminum mask and the external front face panels shall be easily replaceable from within the sign housing.

The ventilation system shall be forced air. The system shall be designed to adequately cool the pixels from all sides along with the front and rear of the display module and all other internal components. The ventilation system shall have the following properties:

(1) Positive pressure (exhaust fans are not acceptable).
(2) The fans shall have ball or roller bearings, shall be permanently lubricated and shall require no periodic maintenance. The fans are to be positioned in such a manner so as to provide a balanced air flow to the ventilation system in the event of failure of any fan.

Access door shall be mounted to an integral doorframe that mounts to the VMS housing using non-corrosive hardware. A continuous vertical stainless steel hinge shall support the door,

and the door shall open outward towards the monotube structure. In the closed position, each door shall latch to its frame with a three-point draw-roller mechanism. The latching mechanism shall include an internal handle and release lever. Door release levers shall be located so that a person with no key and no tools cannot become trapped inside the housing.

Access doors shall be framed and swing open and lock in-place open at a 90 degree angle and 110 degree angle from the VMS housing end wall. The bottom edge of each door shall be at least 3.5-inches from the bottom edge of the VMS housing. This will provide clearance for the doors to swing open over external access platform.

The door will be fitted with an interior and exterior lockable heavy duty handle. Each exterior door shall be furnished with a handle that is pad lock ready and Corbin #2 key lock. Each door shall close around its flanged frame and compress against a closed-cell foam gasket, which adheres to the door. All doors shall contain a stop that retains the door in a 90 and 110-degree open position. When a door is open, the door and its stop shall withstand damaged by a 60 mph wind gust.

The VMS shall be equipped with an OSHA compliant safety rail assembly that when closed across an open access door will prevent service personnel from falling out of the VMS. The VMS shall have a rail assembly provided for each door in the display. The rail assembly shall require no tools to open and close.

The door shall incorporate an open/closed sensor that is detectable by the sign controller and notifies the Central system control software whenever the door is accessed.

Minimum headroom of 72-inches shall be provided in the VMS housing. This free space shall be maintained across the entire width of the VMS housing, with the exception of structural frame members. Structural members shall be designed not to obstruct the free movement of maintenance personnel throughout the VMS interior.

A level aluminum walkway shall be installed in the bottom of the VMS housing. The walkway shall be a minimum of 24-inches wide and it shall run the entire length of the housing, from access door to access door. The top surface of the walkway shall be non-slip and shall be free of obstructions that could trip service personnel. The walkway shall support a load of 300 pounds per linear foot.

The internal structural members shall be extruded aluminum and shall accommodate both the display module mountings while allowing air distribution. The display modules shall be removed and replaced without the use of tools and without disturbing adjacent modules. The sign shall have in cabinet heaters that are sufficient to elevate the temperature within the sign to 30° F above the temperature outside the sign. These heaters shall be controlled by a manually operated automatic shut-off timer in the sign and remotely from central computers.

The system power and communication lines shall each be protected by two stages of surge protection devices. The first stage shall be an arc discharge, gas discharge tube or a thyristor surge protection based unit with local and remote reporting capability. The second stage shall be metal oxide varistor (MOV) based. This second stage shall include a crowbar circuit, that when remotely enabled, shall trip the power circuit breaker when the second stage surge suppressor is activated. In both cases, tripping of each stage (or both if tripped simultaneously) of the surge protection and shall report the power surge condition to the sign controller for report to central. The crowbar shall be an option that is either enabled or disabled

and is selected and downloaded from the central system control software to the sign controller. When this option is enabled, tripping of the second stage of surge protection shall prevent power from reaching any components of the sign until the surge protection has been replaced. When this option is disabled, the sign will continue to function normally after the second stage of surge protection is tripped.

(c) Sign controller:

The sign controller and associated communication equipment shall be installed inside the VMS sign housing or roadside communications cabinet. Each VMS shall be controlled and monitored by its own sign controller. The sign controller shall be a stand-alone microprocessor-based system, which does not require continuous communication with VMS control software in order to perform most VMS control functions.

The sign controller shall meet the following operational requirements:

- Communicate using embedded NTCIP protocol,
- Contain memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation,
- Include a front panel user interface with graphical VFD or LCD and keypad for direct operation and diagnostics as described herein,
- Contain a minimum of three (3) NTCIP-compliant RS232 communication ports,
- Contain a minimum of one (1) NTCIP-compliant Ethernet port with RJ45 connector,
- Contain a minimum of one NTCIP-compliant RS422 communication port with RJ45 connector,
- Have the ability to play volatile messages,
- Contain VMS-specific control firmware (embedded software) that shall monitor all external and internal sensors and communication inputs and control the display modules as directed by external control software and the front panel interface, and
- Have the ability for remote firmware upgrades that error check to eliminate firmware corruption.

NTCIP shall be natively supported in the VMS controller. External protocol converter or translator devices shall not be allowed.

The sign controller shall be programmed to receive and transmit NTCIP compliant sign control commands from the central system control software and laptop computer.

The controller shall have power-up and auto-restart capabilities with programmable default actions when recovering from a power off condition. A hardware watch dog circuit shall provide automatic reset of the controller and communications device. Central control shall have ability to perform a remote command for the controller and communications device reset. The controller shall be able to accept standard UPS shutdown commands via Ethernet or serial interface.

The Controller shall perform all communication, control and feedback functions and shall not require an intermediate control device and be the only sign controller. Communication and control lines between the sign controller and the system interface circuits shall be opto-coupled.

The following shall be mounted inside the main sign housing:

(1) NTCIP compliant VMS controller,
(2) Fold-down laptop shelf and document holder for maintaining sign,
(3) Hardened communication device,
(4) Display system interface circuits,
(5) Local/remote control switch,
(6) Sign to ground voice communication RJ-11 jack,
(7) USB plug-in connection or a serial connection with a USB converter cable for the controller interface,
(8) RS-232 cable (a minimum of 4 feet long to connect the controller interface to a laptop computer), and
(9) A.C. surge protection and communication surge protection.

There shall be an outside controller interface box that shall be made of aluminum or stainless steel, be weather tight, corrosion resistant, and meet NEMA 3R standards. The separate controller interface box shall be mounted as directed by the Engineer. This typically will be on the sign support structure pole furthest from traffic.

The controller interface cabinet shall contain the following assemblies:

(1) Power-on indicator,
(2) Waterproof local/remote switch,
(3) Local control LED indicator,
(4) RS-232cable a minimum of 4 feet long to connect the controller interface to a laptop computer,
(5) 120 VAC GFI outlet, and
(6) For dialup installations, an RJ-11 jack for connecting the dialup phone line shall be installed with in-line surge protection.

(d) Electronics:

All electronic components, except printed circuit boards, shall be commercially available, easily accessible, replaceable and individually removable using conventional electronics repair methods.

All printed circuit boards shall be sealed with a silicone conformal coating.

Components shall be arranged so they are easily accessible for testing and replacement. All circuit designs shall utilize high quality electronic components and shall provide a meantime before failure of at least 3 years.

The VMS shall contain an automatically controlled defog system that warms the VMS front face when the internal VMS relative humidity is near condensation levels. This system shall keep the front face polycarbonate panel free of fog and condensation. The heat generated by the defog system shall not damage any part of the VMS.

The sign and the controller shall be capable of operating with 120/240 VAC, 38 to 50 amp per leg, 60 Hz, single phase power. The sign shall have a 50-amp two-pole breaker (common trip) main, 120/240 VAC, single phase, four wire load center with 20 circuit capability. Each circuit in the sign shall be powered from a circuit breaker. Inside the sign housing, all 120

VAC service lines shall be independently protected by a thermo magnetic circuit breaker at the sign housing entry point. All 120 VAC wiring shall be located in conduit, pull boxes, raceways, or control cabinets as required by the National Electrical Code (NEC). No 120 VAC wiring shall be exposed within or outside of the sign housing. The sign housing shall not be considered as a raceway or control cabinet. There shall be a minimum of three GFI Duplex outlets installed inside the sign housing.

Lighting shall be provided to illuminate the interior of the sign. The lights shall be enclosed in die cast aluminum safety fixtures with twist-on bulb guards secured by a minimum of four set- screws. The lights shall be controlled by an adjustable timer.

The VMS housing shall contain a minimum of one (1) compact fluorescent light (CFL) fixture for every eight (8) feet of VMS housing width. The lamps shall be evenly spaced across the housing ceiling and provide uniform light distribution for maintenance purposes. The light provided by the lamps shall meet the requirements of *ANSI/IESNA RP-7-01, Lighting Industrial Facilities*. Each lamp shall be rated for at least 10,000 hours of operation, have a minimum 30-watt rating, be self -ballasted, and be rated for cold weather operation down to -20º F. Lamp housing shall be heavy duty and enclosed to protect the lamps from damage. The lamps shall have a color temperature of at least 4100ºK.

The pixels shall be amber in color and utilize precision optical performance AlInGaP II LEDs constructed of aluminum indium gallium phosphide. The brightness and color of each pixel shall be uniform over the entire face of the sign.

The brightness and color of each pixel shall be uniform over the entire face of the sign within the 30-degree cone of vision from minimum of 200 feet up to and including 1100 feet in all lighting conditions. The brightness of each LED shall be measured in accordance with CIE Test Method A, as described in CIE 127-1997, Technical Report: measurement of LEDs.

The pixel strings shall be powered from a regulated DC power source and the LED current shall be maintained at 25 plus or minus three milliamperes per string to maximize life of the pixel. The failure of an LED in one string within a pixel shall not affect the operation of any other string or pixel. The LEDs shall be capable of operating in a temperature range of –40 degrees to +100 degrees C. The LEDs shall be moisture resistant epoxy with UV-A and UV-B inhibitors. Pixel power drawn from the DC supplies shall not exceed 1.5 watts per pixel, including the driving circuitry.

A minimum of three photocells shall be installed on the sign. These devices shall permit automatic light intensity measurement of light conditions at each sign location. These photocells shall be mounted in a manner to measure front, rear and ambient light conditions. Provisions shall be made to prevent perceivable brightening of the sign due to stray headlights shining upon the photo sensors at night.

The power supplies shall be paralleled in a diode or a configuration such that one supply may completely fail and the sign will still be supplied with enough power to run 40% of all pixels.

All cables shall be securely clamped or tied in the sign housing. No adhesive attachments will be allowed.

The signs shall be capable of displaying ASCII characters 32 through 126 (including all upper and lower case letters and digits from 0 to 9) at any location in a message line.

(e) Communication:

The sign controller shall be capable of being controlled from the central system control software and the controller interface cabinet via RS-232 serial and Ethernet communications.

The sign controller shall include separate interfaces for communication with the central system control software and the controller interface cabinet.

The communications between the sign controller and the central system control software and controller interface cabinet shall comply with the NEMA National Transportation Communications for ITS Protocol (NTCIP). The sign controller shall support all NTCIP conformance levels, conformance groups, objects, and minimum storage sizes and ranges as specified in APPENDIX A.

In addition to the standard Management Information Base (MIB) objects, the sign shall include any additional manufacturer-specific MIB objects required to support all of the sign and central software functionality defined in this specification and in APPENDIX A.

Dial-up or hardwire multi-drop communication lines shall be protected by two stages of transient voltage suppression devices including MOVS and spark gap arrestor.

Protect low voltage communication lines (twisted pair or coaxial) with multi-stage one- pair or two-pair surge suppressors designed for high-exposure applications, providing common mode and differential mode protection, with a maximum clamping voltage of 10 volts greater than peak DC or maximum AC RMS signal voltage and peak surge current rating of 10kA.

The sign controller shall be capable of being remotely reset from the central system control software.

The sign shall provide a minimum of four (4) input and four (4) output contact closures able to receive digital and or analog signals that will allow up to 15 message activations upon contact closure events. These message activations shall permit standard NTCIP operations to occur and also permit contact closure messages to occur without message activation collisions and or message activation errors. Contact closures shall be remotely accessible using standard NTCIP MIB objects. Contact closures shall be capable of issuing NTCIP traps.

The sign controller shall provide software modules that will allow integration with CDOT Weight-in-Motion (WIM) systems.

The sign controller shall allow user-configuration of maximum and minimum temperature in which to turn fans on and off.

The sign shall have polling capability and at a minimum shall be capable of reporting the status of the following:

(1) Pixel operational status that includes every string of every pixel,
(2) Sign and ambient temperature,
(3) DC power supply status,
(4) The current state (on or off) of each pixel, including any pixel errors, in the actual, currently displayed message without disturbing the message in any way. This shall be real time and shall not be based on a previous pixel test,

(5) Cooling fan status,
(6) Access door alarm,
(7) Communication failure log,
(8) UPS status, and
(9) AC surge protector status.

The controller software shall be capable of displaying the following types of messages:

(1) Static messages capable of displaying any character or set of characters,
(2) Full Graphic capabilities,
(3) Flashing messages with the following ranges of adjustable timing:
    (a) Message time on from 0.5 to 5.0 seconds in 0.1 second increments and
    (b) Message time off from 0.5 to 5.0 seconds in 0.1 second increments, and
(4) Alternating messages capable with the following ranges of adjustable timing:
    (a) Primary message time on from 0.5 to 5.0 seconds in 0.1 second increments,
    (b) Primary message time off from 0 to 5.0 seconds in 0.1 second increments,
    (c) Alternate message time on from 0.5 to 5.0 seconds in 0.1 second increments, and
    (d) Alternate message time off from 0 to 5.0 seconds in 0.1 second increments.

It shall be possible to flash any character or set of characters in an alternating message at the adjustable frequencies listed above for flashing messages. The flashing period shall be a sub-multiple of the associated alternating on time. It shall also be possible to flash any character or set of characters in a static message.

The sign controller shall monitor the photo cell circuits in the sign and convert the measured light intensity into the desired pixel brightness.

(f) Uninterruptable Power Supply (UPS)

The UPS system shall provide “On-Line” dual conversion control.

The UPS shall be rated per the following:

(1) Input Voltage: 85 VAC to 135 VAC
(2) Input Frequency: 48 to 62 Hz
(3) Output Voltage:120 VAC plus or minus 3 percent
(4) Output Frequency: 60 Hz
(5) Power: VA required to run; VMS sign control electronics, and communication equipment, allowing the sign functionality during a power outage for a minimum of 8 hours**.**

The unit shall be designed for a hot swap of components and shall not compromise existing VMS wiring. The unit shall provide for RS232 communication and contact closures for alarm functions. The unit shall be temperature rated to operate from 0 degree C to +40 degree C.

The UPS system shall be capable of producing simultaneously-fully regenerated, conditioned power with true sine wave and continuous AC outputs with stand by capability.

The unit shall have a re-settable power event counter to record the number of power utility failures, a battery run-time counter and temperature compensated battery charging.

The UPS System shall be capable of providing continuous, fully conditioned (both voltage and frequency), regulated, sinusoidal AC power to selected devices such as controllers, modems, 5 volt power supplies, and sign face drivers.

Wiring shall comply with national electrical code (NEC) standards and approved wiring methods. Properly rated SO/SJO cords shall be allowed to allow easy replacement of the UPS System.

The UPS shall be 19-inch rack mountable and shall be accompanied with 19-inch rack mountable aluminum battery shelves for installation in the VMS.

The UPS shall consist of two major components, the Electronics Module and the Battery System.

(1) The Electronics Module shall consist of the following:
   A) True Sine wave, high frequency inverter.
   B) Minimum 3-stage, temperature compensated, battery charger
   C) For connection from the Electronics Module to the Battery System, a dedicated harness shall be provided with quick-release, keyed, circular connectors, and braided nylon sleeving over all conductors.
   D) Local and remote control of UPS functions
   E) Local and remote communications capabilities

(2) The Battery System shall consist of the following:
   A) Shall run sign electronics, and communication equipment, for a minimum of 8 hours.
   B) The batteries shall be comprised of extreme temperature, deep cycle AGM/VRLA (Absorbed Glass Mat/Valve Regulated Lead Acid) batteries that have been field proven and tested by the U.S. military.
   C) Batteries shall be certified to operate at extreme temperatures from -40’C to +74’C.
   D) The batteries shall be provided with appropriate interconnect wiring and a corrosion-resistant mounting trays and/or brackets appropriate for the location into which they will be installed.
   E) The interconnect cable shall be protected with abrasion-resistant nylon sheathing.
   F) Battery construction shall include heavy-duty, inter-cell connections for low-impedance between cells and heavy-duty plates to withstand shock and vibration.

The UPS System shall come standard with software, RS232 interface via a DB-9F connector (optional SNMP Adapter for TCP/IP protocols) allowing full, interactive, remote computer monitoring and control of the UPS functions. The software shall allow the user to set up all operational parameters either locally or remotely and test the functionality of the unit.

The UPS Alarm Function Monitoring shall come standard with a DB-9F connector with open collectors (40 V @ 20 mA) indicating:

(1) Loss of Utility Power
(2) Inverter Failure
(3) Low Battery

The UPS Front Panel Controls shall come standard with Power ON, Cold (DC) Start, Alarm Silence, Battery Test, Bypass Breaker and DC/Battery Breaker.

Reliability shall be calculated with mean time between failures (MTBF) of 100,000 hours based on component ratings.

(g) Manufacturer Qualifications

The manufacturer shall supply experience documentation showing that the manufacturer has been in business, under the current corporate name, designing and manufacturing Interstate LED Variable Message Signs for a minimum of 5 years; and that the manufacturer has in operation a minimum of 100 walk-in LED VMSs. These 100 VMS shall be from 5 separate projects and operational for a minimum of 5 years.

(h) Warranty

The Contractor shall ensure that the manufacturer can warranty the sign and sign controller for a minimum of 3 years for all parts returned to the factory, and full telephone technical support at no additional charge to the Department. The technical support shall include access to a trained service representative who can respond within 24 hours to questions related to all VMS related equipment problems and maintenance issues. The technical support shall include lifetime post warranty telephone and technical support access.

The UPS equipment shall include a minimum two year warranty on parts and labor. Batteries shall include a minimum two year pro rated warranty. Vendor shall be responsible for processing warranty repairs.

A repair option shall be available for UPS equipment no longer covered by the warranty period. Repair cost shall include all labor and materials necessary to complete the repair. Vendor shall be responsible for processing non-warranty repairs.

CONSTRUCTION REQUIREMENTS

Contractor shall be fully responsible for the delivery of the sign to the installation site and any damages that occur in the installation delivery process.

The LED VMS shall be installed in accordance with manufacturer's recommendations. A qualified factory representative shall be available on site to ensure proper installation and testing.

The Contractor shall be responsible for locating the nearest electrical power and telephone sources and connecting those sources to the appropriate terminations with the LED VMS. The Contractor shall cooperate with the local electrical and telephone utilities to establish a service accounts at the direction of the Engineer.

A minimum of five copies of the operations manual detailing the electrical schematics, operation and maintenance of the VMS system, including spare software copies, shall be provided. Additional copies may be requested by the Engineer. One copy of the manual shall remain inside the sign housing or control cabinet. One copy shall be mailed to the Colorado Transportation Management Center at 425 C Corporate Circle, Golden, Colorado 80401.

As part of the VMS submittals, the Contractor shall note the firmware that is planned to be used.

See project specific Testing & Integration Plan for additional requirements for VMSs.

Appendix A

NTCIP Requirements

This portion of the specification defines the detailed NTCIP requirements for the Variable Message Signs covered by the project specifications.

This specification references several standards through their NTCIP designated names. The following list provides the full reference to the current version of each of these standards. In many cases, the standard is more widely known by its original NEMA assigned number, in these cases, the NEMA number is also identified. The content of the NEMA standard is identical to that of the NTCIP standard.

Each NTCIP Component covered by these project specifications shall implement the most recent version of the standard that is at the stage of Recommended or higher as of January, 01, 2011, including any and all Approved or Recommended Amendments to these standards as of the same date. It is the ultimate responsibility of the vendor to monitor NTCIP activities to discover any more recent documents.

General Requirements:

Subnet Level

NTCIP Components may support additional Subnet Profiles at the vendor's option. At any one time, only one Subnet Profile shall be active on a given serial port of the NTCIP Component. If the NTCIP Component has a serial port that supports multiple Subnet Profiles, the NTCIP Component shall be configurable to allow the field technician to activate the desired Subnet Profile and shall provide a visual indication of the currently selected Subnet Profile.

Transport Level

Each NTCIP Component shall comply with NTCIP 2202, (NEMA TS 3.Internet). NTCIP Components may support additional Transport Profiles at the manufacturer's option. Response datagrams shall use the same Transport Profile used in the request. Each NTCIP Component shall support the receipt of datagrams conforming to any of the identified Transport Profiles at any time.

Application Level

Each LED VMS shall comply with NTCIP 2301, (NEMA TS 3.AP-STMF), as a Managed Agent and shall meet the requirements for Conformance Level 1 (NOTE – see Amendment to standard). Simple network management protocol (SNMP) shall be required and simple transportation management protocol (STMP) shall not be required. An NTCIP Component may support additional Application Profiles at the manufacturer's option. Responses shall use the same Application Profile used by the request. Each NTCIP Component shall support the receipt of Application data packets at any time allowed by the subject standards.

Information Level

Each NTCIP Component shall provide Full, Standardized Object Range Support of all objects required by these procurement specifications, unless otherwise indicated below. The maximum Response Time for any object or group of objects shall be 200 milliseconds.

The vendor's software shall implement all mandatory objects of the mandatory conformance group defined in NTCIP 1201, (NEMA TS 3.4) Global Object Definitions:

Configuration Conformance Group – Section 3.1

Security Conformance Group (new in Amendment 1)

The vendor's software shall implement the mandatory objects of the optional conformance groups defined in NTCIP 1201, (NEMA TS 3.4), Global Object Definitions:

Time Management Conformance Group – Section 3.3

TimeBase Event Schedule Conformance Group – Section 3.4

Report Conformance Group – Section 3.5

The vendor's software shall implement all mandatory objects of all mandatory conformance groups defined in NTCIP 1203, (NEMA TS 3.6) Object Definitions for DYNAMIC MESSAGE SIGN (LED) (OVERHEAD)s:

Sign Configuration Conformance Group – Section 4.1

Message Table Conformance Group – Section 4.6

Sign Control Conformance Group – Section 4.7

The vendor's software shall implement all mandatory objects of the optional conformance groups defined in NTCIP 1203, (NEMA TS 3.6), Object Definitions for DYNAMIC MESSAGE SIGN (LED) (OVERHEAD)s:

GUI Appearance – Section 4.2

Font Definition – Section 4.3

DMS Sign Configuration – Section 4.4

MULTI Configuration – Section 4.5

Default Message – Section 4.8

MULTI Error – Section 4.10

Illumination/Brightness – Section 4.11

Scheduling – Section 4.12

Auxiliary I/O – Section 4.13

Sign Status – Section 4.14

Status Error – Section 4.15

Pixel Error Status – Section 4.16

Fan Error Status – Section 4.18

Temperature Status – Section 4.17

The vendor's software shall implement the following optional objects defined in NTCIP 1203, (NEMA TS 3.6):

dmsMessageBeacon – Section 2.6.1.1.1.8.6

dmsSWReset – Section 2.7.1.1.1.1

dmsMessageTimeRemaining – Section 2.7.1.1.1.4
dmsShortPowerRecoveryMessage – Section 2.7.1.1.1.8
dmsLongPowerRecoveryMessage – Section 2.7.1.1.1.9
dmsShortPowerLossTime – Section 2.7.1.1.1.10

dmsResetMessage – Section 2.7.1.1.1.11

dmsCommunicationsLossMessage – Section 2.7.1.1.1.12 dmsTimeCommLoss – Section 2.7.1.1.1.13

dmsPowerLossMessage – Section 2.7.1.1.1.14

dmsEndDurationMessage – Section 2.7.1.1.1.15
dmsMultiOtherErrorDescription – Section 2.7.1.1.1.20

dmsStatDoorOpen – Section 2.11.1.1.1.6

fanFailures – Section 2.11.2.1.1.8

fanTestActivation – Section 2.11.2.1.1.9
tempMinCtrlCabinet – Section 2.11.4.1.1.1
tempMaxCtrlCabinet – Section 2.11.4.1.1.2
tempMinAmbient – Section 2.11.4.1.1.3

tempMaxAmbient – Section 2.11.4.1.1.4
tempMinSignHousing – Section 2.11.4.1.1.5 tempMaxSignHousing – Section 2.11.4.1.1.6

The vendor's software shall implement the following tags (opening and closing where defined) of MULTI as defined in NTCIP 1203, (NEMA TS 3.6), Object Definitions for DYNAMIC MESSAGE SIGN (LED) (OVERHEAD)s:

MULTI Tag

1 Field

2 Flash

3 Font

4 Hexadecimal Character

5 Justification Line

6 Justification Page

7 Moving Text

8 New Line

9 New Page

10 Page Time

11 Spacing – Character

The Field Tag shall support the following field ID's:

Field Tag ID	***Description***	
1	1	Time, 12-hour format (no AM/PM indicator)
2	2	Time, 24-hour format
3	3	Temperature in degrees Celsius
4	4	Temperature in degrees Fahrenheit
5	7	Day of week
6	8	Day of month
7	9	Month of year
8	10	Year, 2-digits
9	11	Year, 4-digits

Sizes and Ranges

All objects required by these procurement specifications shall support all values within its standardized range. The standardized range is defined by a size, range, or enumerated listing indicated in the object's SYNTAX field and/or through descriptive text in the object's DESCRIPTION field of the relevant standard. The following provides the current listing of known variances for this project:

Object	***Reference***	***Minimum Project Requirements***
NTCIP 1201 (TS 3.4)		
moduleTableEntry	2.2.3	Shall contain at least one row with module Type equal to 3 (software). The module Make shall specify the name of the manufacturer; the module Model shall specify the manufacturer's name of the component and the model Version shall indicate the model version number of the component.
communityNamesMax	2.8.2	Shall be at least 4.
maxTimeBaseScheduleEntries		2.4.3.1 7
maxDayPlans	2.4.4.1	7
maxDayPlanEvents	2.4.4.2	7
maxEventLogConfigs	2.5.1	50
eventConfigMode	2.5.2.3	2,3,and 4
maxEventLogSize	2.5.3	200
maxEventClasses	2.5.5	7

maxGroupAddress	2.7.1	1
maxEventLogSize	2.5.3	200
maxEventClasses	2.5.5	7
maxGroupAddress	2.7.1	1

NTCIP 1203 v0239b (TS 3.6)

dmsNumPermanentMsg	5.6.1	100
dmsMaxChangeableMsg	5.6.3	100
dmsFreeChangeableMemory	5.6.4	500 MB
dmsMaxVolatileMsg	5.6.6	100
dmsFreeVolatileMemory	5.6.7	500 MB
dmsMsgMultiString	5.6.8.3	See attached table
dmsControlMode	5.7.1	2,4,5
numFonts	5.4.1	10
maxFontCharacters	5.4.3	127
DMSCharacterHeightPixels	5.3.1	7
DMSCharacterWidthPixels	5.3.2	5
DMSSignHeightPixels	5.3.3	27
DMSSignWidthPixels	2.3.1.1.1.4	105
DMSHorizontalPitch	5.3.5	66-70 mm
DMSVerticalPitch	5.3.6	66-70 mm
defaultBackgroundColor	5.5.1	0 (black)
defaultJustificationLine	5.5.9	2,3,4
defaultJustificationPage	5.5.11	2,3,4
defaultFlashOn	5.5.3	0.5 to 5.0
defaultFlashOff	5.5.5	0.5 to 5.0
defaultPageOnTime	5.5.13	0.5 to 5.0
defaultPageOffTime	5.5.15	0.5 to 5.0
defaultCharacterSet	5.5.21	eightBit (2)
dmsMaxNumberPages	5.5.24	6
dmsColorScheme	5.5.22	1 (monochrome1bit)
dmsSupportedMultiTags	5.5.23	See Section 614 more Multi Tags details.

Documentation

The Software shall be supplied with full documentation and a CD-Rom containing ASCII versions of the following Management Information Base (MIB) files in Abstract Syntax Notation 1 (ASN.1) format:

- Relevant version of each official standard MIB Module referenced by the device functionality.
- If the device does not support the full range of any given object within a Standard MIB Module, a vendor specific version of the official Standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. The filename of this file shall be identical to the standard MIB Module, except that it will have the extension ".man".
- A MIB Module in ASN.1 format containing any and all manufacturer-specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
- A MIB containing any other objects supported by the device.

The vendor shall allow the use of any and all of this documentation by any party authorized by CDOT for systems integration purposes at any time initially or in the future, regardless of what parties are involved in the systems integration effort.

REVISION OF SECTION 614
VARIABLE TOLL MESSAGE SIGN (VTMS)

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

DESCRIPTION

This work consists of furnishing and installing a Light Emitting Diode Variable Toll Message Sign (LED VTMS). The LED VTMS shall be equipped with the ability to display 7 characters of text at a height of 18-inch tall characters. The pixel matrix shall be a minimum of 7x35. The sign shall include a power shut off mounted to the sign structure near the controller interface cabinet. The sign shall be capable of operating without any decrease in performance over a temperature range of -34° F to +140° F with a relative humidity of 0 to 99 percent, non-condensing. The sign shall have a minimum design life of 20 years.

MATERIALS

(a) Certifications: Prior to start of the installation of the LED VTMS the Contractor shall provide the following certifications to CDOT for Approval:

(1) Certification showing that the manufacturer of the LED VTMS is fully compliant with ISO 9001 as of the bid date for this project. The ISO 9001 Certification shall apply to the facility, and to the design, fabrication, installation, and maintenance of the LED VTMS. The facility where this company actually designs and manufactures the LED VTMS shall be ISO 9001:2000 certified a minimum of one year prior to the bid date for this project.
(2) Working drawings showing the sign housing shall be sealed by an Engineer registered in the State of Colorado and shall be submitted in accordance with subsection 105.02.
(3) Certification showing that welding of the LED VTMS housing is in accordance with the American Welding Society (AWS) Standards, ANSI/AWS D1.2-97. The LED VMS manufacturer's welders and welding procedures shall be certified by an ANSI/AWS Certified Welding Inspector to the ANSI/AWS D1.2-97 Structural Welding Code for Aluminum.
(4) Certification that all aluminum face materials have a coating that meets or exceeds the requirements of the American Architectural Manufacturers Association (AAMA) Specifications Publication No. 2605.
(5) Certification that the LEDs were tested and binned in accordance with the CIE Test Method A.
(6) Documentation and information on software as described in Appendix A of this document.
(7) Documentation verifying the VTMS is listed by an accredited 3rd party testing organization for conformance to UL48 and UL 1433.
(8) All workmanship shall comply with IPC-A-610C, Class 2 titled "Acceptability of Electronic Assemblies".
(9) Documentation providing proof PCB silicon conformal coating conformance to MIL-I-46058C Type SR and IPC-CC-830.

(10) Documentation that the sign's structural integrity is in Conformance to AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals (Third Draft).
(11) Documentation that the VMS conforms to the Transient Protection and Vibration of the NEMA Standard TS4, Section2.

(b) Sign Housing: All component parts shall be easily and readily accessible by a single person for inspection and maintenance. The housing shall be weather tight, and compliant to the NEMA 3R Standard.

All parts shall be made of corrosion resistant materials, such as plastic, stainless steel or aluminum. Painted steel is not acceptable. No self-tapping screws shall be used. The exterior front face surfaces shall be finish coated by a system that meets or exceeds the AAMA Specification No. 2605. The finish shall be matte black. The main body of the sign housing shall be constructed of aluminum with a natural mill finish. All exterior seams shall be continuously welded by an inert gas process, except for the coated fascia material.

The glazing shall be constructed of clear polycarbonate sheets with surfaces that resist hazing from UV light. The glazing shall be protected by a coated 0.090 inch aluminum mask with apertures punched directly in front of each pixel. The coating shall meet or exceed the AAMA Specification No. 2605.

For surge protection, the system power shall be protected by two stages of transient voltage suppression devices. Tripping of each stage (or both if tripped simultaneously) of the surge protection shall cause the sign controller to call central and report the error condition (for dialup operation) or report the error condition to central on the next poll (for multi-drop operation). There shall be an option that is either enabled or disabled and is selected and downloaded from the central system control software to the sign controller. When this option is enabled, tripping of the second stage of surge protection shall prevent power from reaching any components of the sign until the surge protection has been replaced. When this option is disabled, the sign will continue to function normally after the second stage of surge protection is tripped.

(c) Sign controller: The sign controller shall be installed into the Communications Cabinet on the side of the road. The sign controller shall allow for control and monitoring of multiple VTMS inserts. The sign controller shall be a stand-alone microprocessor-based system, which does not require continuous communication with VTMS control software in order to perform most VTMS control functions.

The sign controller shall meet the following operational requirements:

- Communicate using embedded National Transportation Communications for ITS Protocol (NTCIP) protocol
- Contain memory for storing changeable and permanent messages, schedules, and other necessary files for controller operation
- Include a front panel user interface with graphical VFD or LCD and keypad for direct operation and diagnostics as described herein
- Contain a minimum of two (2) NTCIP-compliant RS232 communication ports
- Contain a minimum of one (1) NTCIP-compliant Ethernet port with RJ45 connector

- Have the ability to play volatile messages
- Contain VMS-specific control firmware (embedded software) that shall monitor all external and internal sensors and communication inputs and control the display modules as directed by external control software and the front panel interface
- Ability for remote firmware upgrades that error check to eliminate firmware corruption

NTCIP shall be natively supported in the VTMS controller. External protocol converter or translator devices shall not be allowed. The sign controller shall be programmed to receive and transmit NTCIP compliant sign control commands from the central system control software and laptop computer. The controller shall have power-up and auto-restart capabilities with programmable default actions when recovering from a power off condition. A hardware watch dog circuit shall provide automatic reset of the controller and communications device. Central control shall have ability to perform a remote command for the controller and communications device reset. The controller shall be able to accept standard UPS shutdown commands via Ethernet or serial interface.

The Controller shall perform all communication, control and feedback functions and shall not require an intermediate control device and be the only sign controller. Communication and control lines between the sign controller and the system interface circuits shall be opto-coupled.

(d) Electronics: All electronic components, except printed circuit boards, shall be commercially available, easily accessible, replaceable and individually removable using conventional electronics repair methods.

All Printed Circuit Boards (PCBs) shall be completely conformal coated with a silicone resin that meets the IPC CC-830 standard. The exception for this coating shall be the pixels on the front of the PCB of the LED motherboards and any components in sockets.

All integrated circuits shall be individually replaceable. Components shall be arranged so they are easily accessible for testing and replacement. All circuit designs shall utilize high quality electronic components and shall provide a meantime before failure of at least 3 years.

The sign and the controller shall be capable of operating with 120/240 VAC, 20 amp per leg, 60 Hz, single phase power. Each circuit in the sign shall be powered from a circuit breaker. Inside the roadside cabinet, all 120 VAC service lines shall be independently protected by a thermo-magnetic circuit breaker at the sign housing entry point. All 120 VAC wiring shall be located in conduit, pull boxes, raceways, or control cabinets as required by the National Electrical Code (NEC). No 120 VAC wiring shall be exposed within or outside of the sign housing.

The pixels shall be red/green/amber in color and utilize precision optical performance AlInGaP II LEDs (for red LEDs) or InGaN LEDs (for green LEDs) constructed of aluminum indium gallium phosphide. The brightness and color of each pixel shall be uniform over the entire face of the sign within the 30-degree cone of vision from minimum of 200 feet up to and including 1,100 feet in all lighting conditions. Each pixel shall be 40 candelas at 20mA as measured by the sum of the brightness of the individual LEDs in each pixel. The brightness of each LED shall be measured in accordance with CIE Test Method A, as described in CIE 127-1997, Technical Report: Measurement of LEDs.

Each pixel shall contain two strings of LEDs. The pixel strings shall be powered from a regulated DC power source and the LED current shall be maintained at 25 plus or minus three milliamperes per string to maximize life of the pixel. The failure of an LED in one string within a pixel shall not affect the operation of any other string or pixel. The LEDs shall be capable of operating in a temperature range of –40 degrees to +100 degrees C. The LEDs shall be moisture resistant epoxy with UV-A and UV-B inhibitors.

Pixel power drawn from the DC supplies shall not exceed 1.5 watts per pixel, including the driving circuitry.

A minimum of one photocell shall be installed on the sign. This device shall permit monitoring of light conditions at each sign location and automatic selection of light intensity levels. The method or algorithm used to calculate the intensity level shall be determined by the manufacturer and tested under real-world lighting conditions.

The power supplies shall be paralleled in a diode OR configuration such that one supply may completely fail and the sign will still be supplied with enough power to run 40% of all pixels. The power supply shall be located inside the roadside cabinet and not in the sign. The Contractor shall work with the Vendor to determine proper cabling requirements from the cabinet to the sign.

All cables shall be securely clamped/tied in the sign housing. No adhesive attachments will be allowed.

The signs shall be capable of displaying ASCII characters 32 through 126 (including all upper and lower case letters and digits from 0 to 9) at any location in a message line.

The Contractor shall be responsible for locating the nearest electrical power and CDOT communication sources and connecting those sources to the appropriate terminations with the LED VTMS. The Contractor shall cooperate with the local electrical and communication utilities to establish a service accounts at the direction of the Engineer.

(e) Communication: The sign controller shall be capable of being controlled from the central system control software and the controller interface cabinet via RS-232 serial and Ethernet communications.

The sign controller shall include separate interfaces for communication with the central system control software and the controller interface cabinet.

The communications between the sign controller and the central system control software and controller interface cabinet shall comply with the NEMA NTCIP. The sign controller shall support all NTCIP conformance levels, conformance groups, objects, and minimum storage sizes and ranges as specified in APPENDIX A.

In addition to the standard Management Information Base (MIB) objects, the sign shall include any additional manufacturer-specific MIB objects required to support all of the sign and central software functionality defined in this specification and in APPENDIX A.

Dial-up or hardwire multi-drop communication lines shall be protected by two stages of transient voltage suppression devices including MOVS and spark gap arrestor.

The sign controller shall be capable of being remotely reset from the central system control software.

The sign controller shall allow user-configuration of maximum and minimum temperature in which to turn fans on and off.

The sign shall have polling capability and at a minimum shall be capable of reporting the status of the following:

(1) Pixel operational status that includes every string of every pixel
(2) Sign and ambient temperature
(3) DC power supply status
(4) The current state (on or off) of each pixel, including any pixel errors in the actual, currently displayed message without disturbing the message in any way. This shall be real time and shall not be based on a previous pixel test.
(5) Communication failure log
(6) UPS status
(7) AC surge protector status

The controller software shall be capable of displaying static messages, including any character or set of characters

It shall be possible to flash any character or set of characters in an alternating message at the adjustable frequencies listed above for flashing messages. The flashing period shall be a sub-multiple of the associated alternating on time. It shall also be possible to flash any character or set of characters in a static message.

The sign controller shall monitor the photo cell circuits in the sign and convert the measured light intensity into the desired pixel brightness.

MANUFACTURER QUALIFICATIONS

The manufacturer shall supply experience documentation showing that the manufacturer has been in business, under the current corporate name, designing and manufacturing freeway LED Variable Message Signs of a similar type for a minimum of 5 years; and that the manufacturer has in operation a minimum of 100 LED VMS. These 100 VMS shall be from 5 separate projects and operational for a minimum of 5 years.

WARRANTY

Standard Warranty. The contractor shall ensure that the manufacturer can warranty the product for a minimum of 3 years for all parts returned to the factory, and full telephone technical support at no additional charge to the Department. The technical support shall include access to a trained service representative who can respond within 24 hours to questions related to all VTMS related equipment problems and maintenance issues.

CONSTRUCTION REQUIREMENTS

Contractor shall be fully responsible for the delivery of the sign to the installation site and any damages that occur in the installation and delivery process.

The LED VTMS shall be installed in accordance with manufacturer's recommendations. A qualified factory representative shall be available on site to ensure proper installation and testing.

A minimum of five copies of the operations manual detailing the electrical schematics, operation and maintenance of the VTMS system, including software copies, shall be provided. Additional copies may be requested by CDOT. One copy of the manual shall remain inside the sign controller cabinet on the side of the road. One copy shall be delivered to the CDOT construction project engineer.

See project specific Testing & Integration Plan for additional requirements for VTMSs.

Appendix A

NTCIP Requirements

This portion of the specification defines the detailed NTCIP requirements for the Variable Message Signs covered by the project specifications.

This specification references several standards through their NTCIP designated names. The following list provides the full reference to the current version of each of these standards. In many cases, the standard is more widely known by its original NEMA assigned number, in these cases, the NEMA number is also identified. The content of the NEMA standard is identical to that of the NTCIP standard.

Each NTCIP Component covered by these project specifications shall implement the most recent version of the standard that is at the stage of Recommended or higher as of Sunday, April 03, 2001, including any and all Approved or Recommended Amendments to these standards as of the same date. It is the ultimate responsibility of the vendor to monitor NTCIP activities to discover any more recent documents.

General Requirements:

Transport Level

Each NTCIP Component shall comply with NTCIP 2202 (NEMA TS 3.Internet). NTCIP Components may support additional Transport Profiles at the manufacturer's option. Response datagrams shall use the same Transport Profile used in the request. Each NTCIP Component shall support the receipt of datagrams conforming to any of the identified Transport Profiles at any time.

Application Level

Each VMS shall comply with NTCIP 2301 (NEMA TS 3.AP-STMF) as a Managed Agent and shall meet the requirements for Conformance Level 1 (NOTE – See Amendment to standard). SNMP shall be required and STMP shall not be required. An NTCIP Component may support additional Application Profiles at the manufacturer's option. Responses shall use the same Application Profile used by the request. Each NTCIP Component shall support the receipt of Application data packets at any time allowed by the subject standards.

Information Level

Each NTCIP Component shall provide Full, Standardized Object Range Support of all objects required by these procurement specifications, unless otherwise indicated below. The maximum Response Time for any object or group of objects shall be 200 milliseconds.

The vendor's software shall implement all mandatory objects of the mandatory conformance group defined in NTCIP 1201, (NEMA TS 3.4) Global Object Definitions:

- Configuration Conformance Group – Section 3.1
- Security Conformance Group (new in Amendment 1)

The vendor's software shall implement the mandatory objects of the optional conformance groups defined in NTCIP 1201 (NEMA TS 3.4) Global Object Definitions:

- Time Management Conformance Group – Section 3.3
- TimeBase Event Schedule Conformance Group – Section 3.4
- Report Conformance Group – Section 3.5

The vendor's software shall implement all mandatory objects of all mandatory conformance groups defined in NTCIP 1203, (NEMA TS 3.6) Object Definitions for Variable Message Signs:

- Sign Configuration Conformance Group – Section 4.1
- Message Table Conformance Group – Section 4.6
- Sign Control Conformance Group – Section 4.7

The vendor's software shall implement all mandatory objects of the optional conformance groups defined in NTCIP 1203 (NEMA TS 3.6) Object Definitions for Variable Message Signs:

- GUI Appearance – Section 4.2
- Font Definition – Section 4.3
- VMS Sign Configuration – Section 4.4
- MULTI Configuration – Section 4.5
- Default Message – Section 4.8
- MULTI Error – Section 4.10
- Illumination/Brightness – Section 4.11
- Scheduling – Section 4.12
- Auxiliary I/O – Section 4.13
- Sign Status – Section 4.14
- Status Error – Section 4.15
- Pixel Error Status – Section 4.16
- Fan Error Status – Section 4.18
- Temperature Status – Section 4.17

The vendor's software shall implement the following optional objects defined in NTCIP 1203, (NEMA TS 3.6):

- dmsMessageBeacon – Section 2.6.1.1.1.8.6
- dmsSWReset – Section 2.7.1.1.1.1
- dmsMessageTimeRemaining – Section 2.7.1.1.1.4
- dmsShortPowerRecoveryMessage – Section 2.7.1.1.1.8
- dmsLongPowerRecoveryMessage – Section 2.7.1.1.1.9
- dmsShortPowerLossTime – Section 2.7.1.1.1.10

- dmsResetMessage – Section 2.7.1.1.1.11
- dmsCommunicationsLossMessage – Section 2.7.1.1.1.12
- dmsTimeCommLoss – Section 2.7.1.1.1.13
- dmsPowerLossMessage – Section 2.7.1.1.1.14
- dmsEndDurationMessage – Section 2.7.1.1.1.15
- dmsMultiOtherErrorDescription – Section 2.7.1.1.1.20
- dmsStatDoorOpen – Section 2.11.1.1.1.6
- fanFailures – Section 2.11.2.1.1.8
- fanTestActivation – Section 2.11.2.1.1.9
- tempMinCtrlCabinet – Section 2.11.4.1.1.1
- tempMaxCtrlCabinet – Section 2.11.4.1.1.2
- tempMinAmbient – Section 2.11.4.1.1.3
- tempMaxAmbient – Section 2.11.4.1.1.4
- tempMinSignHousing – Section 2.11.4.1.1.5
- tempMaxSignHousing – Section 2.11.4.1.1.6

The vendor's software shall implement the following tags (opening and closing where defined) of MULTI as defined in NTCIP 1203 (NEMA TS 3.6) Object Definitions for Variable Message Signs:

MULTI Tag	
1	Field
2	Flash
3	Font
4	Hexadecimal Character
5	Justification Line
6	Justification Page
7	Moving Text
8	New Line
9	New Page
10	Page Time
11	Spacing – Character

The Field Tag shall support the following field ID's:

Field Tag ID	**Description**	
1	1	Time, 12-hour format (no AM/PM indicator)
2	2	Time, 24-hour format
3	3	Temperature in degrees Celsius
4	4	Temperature in degrees Fahrenheit
5	7	Day of week
6	8	Day of month
7	9	Month of year
8	10	Year, 2-digits
9	11	Year, 4-digits

Sizes and Ranges

All objects required by these procurement specifications shall support all values within its standardized range. The standardized range is defined by a size, range, or enumerated listing indicated in the object's SYNTAX field and/or through descriptive text in the object's DESCRIPTION field of the relevant standard. The following provides the current listing of known variances for this project:

Object	Reference	Minimum Project Requirements
NTCIP 1201 (TS 3.4)		
moduleTableEntry	2.2.3	Shall contain at least one row with moduleType equal to 3 (software). The moduleMake shall specify the name of the manufacturer, the moduleModel shall specify the manufacturer's name of the component and the modelVersion shall indicate the model version number of the component.
communityNamesMax	2.8.2	Shall be at least 4.
maxTimeBaseScheduleEntries	2.4.3.1	7
maxDayPlans	2.4.4.1	7
maxDayPlanEvents	2.4.4.2	7
maxEventLogConfigs	2.5.1	50
eventConfigMode	2.5.2.3	2,3,and 4
maxEventLogSize	2.5.3	200
maxEventClasses	2.5.5	7
maxGroupAddress	2.7.1	1
NTCIP 1203 (TS 3.6)		
dmsNumPermanentMsg	2.6.1.1.1.1	50
dmsMaxChangeableMsg	2.6.1.1.1.3	50
dmsFreeChangeableMemory	2.6.1.1.1.4	50KB
dmsMaxVolatileMsg	2.6.1.1.1.6	50
dmsFreeVolatileMemory	2.6.1.1.1.7	50KB
dmsMsgMultiString	2.6.1.1.1.8.3	See attached table
dmsControlMode	2.7.1.1.1.1	2,4,5
numFonts	2.4.1.1.1.1	4
maxFontCharacters	2.4.1.1.1.3	127
vmsCharacterHeightPixels	2.3.1.1.1.1	5
vmsCharacterWidthPixels	2.3.1.1.1.2	7
vmsSignHeightPixels	2.3.1.1.1.3	3
vmsSignWidthPixels	2.3.1.1.1.4	10
vmsHorizontalPitch	2.3.1.1.1.5	70mm
vmsVerticalPitch	2.3.1.1.1.6	70mm
defaultBackgroundColor	2.5.1.1.1.1	0 (black)
defaultForegroundColor	2.5.1.1.1.2	9 (amber)
defaultJustificationLine	2.5.1.1.1.6	2,3,4
defaultJustificationPage	2.5.1.1.1.7	2,3,4
defaultFlashOn	2.5.1.1.1.3	0.5 to 5.0
defaultFlashOff	2.5.1.1.1.4	0.5 to 5.0

defaultPageOnTime	2.5.1.1.1.8	0.5 to 5.0
defaultPageOffTime	2.5.1.1.1.9	0.5 to 5.0
defaultCharacterSet	2.5.1.1.1.10	eightBit (2)
numActionTableEntries	2.9.1.1.1.1	15

Documentation

Software shall be supplied with full, electronic documentation containing ASCII versions of the following MIB files in Abstract Syntax Notation 1 (ASN.1) format:

- The relevant version of each official standard MIB Module referenced by the device functionality.
- If the device does not support the full range of any given object within a Standard MIB Module, a vendor specific version of the official Standard MIB Module with the supported range indicated in ASN.1 format in the SYNTAX and/or DESCRIPTION fields of the associated OBJECT TYPE macro. The filename of this file shall be identical to the standard MIB Module, except that it will have the extension ".man".
- A MIB Module in ASN.1 format containing any and all manufacturer-specific objects supported by the device with accurate and meaningful DESCRIPTION fields and supported ranges indicated in the SYNTAX field of the OBJECT-TYPE macros.
- A MIB containing any other objects supported by the device.

The vendor shall allow the use of any and all of this documentation by any party authorized by CDOT for systems integration purposes at any time initially or in the future, regardless of what parties are involved in the systems integration effort.

REVISION OF SECTION 614
WEATHER MONITORING SYSTEM

Section 614 of the Standard Specifications is hereby revised for this project as follows:

DESCRIPTION

This work consists of furnishing, installing, and configuring a weather monitoring station (WMS) at the locations described in the Technical Requirements. The WMS shall be specifically designed to monitor and collect real time atmospheric and pavement conditions along with color still frame video images of the roadway. The WMS shall be capable of sending this information to a centralized computer system compatible with existing CDOT ITS infrastructure. The CDOT server will poll the WMS to ask for data on a preset time interval specified by CDOT to transfer and refresh its data. The data from the Remote Processing Unit (RPU) shall seamlessly integrate with the existing CDOT WMS network servers.

The Contractor shall provide a detailed description (technical cut sheets) of the WMS to be supplied and the experience of the vendor/manufacturer in supplying such WMS to other agencies. The Contractor shall also provide written justification of the selection process used in the selection of a WMS vendor/manufacturer. Such justification shall assure that CDOT receives a state of the art WMS from a responsible vendor/manufacturer that is compatible with the existing statewide WMS system currently in place. CDOT may require the Contractor to document the proposed WMS can provide interoperability and connectivity to the existing statewide WMS system. The WMS equipment vendor chosen by the contractor must have at least 10 successful WMS installations in North America. As part of the equipment approval process, CDOT may ask the Contractor to provide the names of at least ten (10) agencies, with names, telephone numbers and contact person to verify said WMS installations were successful.

After completion of the equipment installation, the equipment manufacturer representative shall perform all final system checks, sensor alignments, software setup, and software configuration to provide a fully operational WMS. The equipment vender shall provide a limited, on-site warranty covering all equipment for a 12-month period from the WMS commissioning date.

MATERIALS

The WMS shall include a remote processing unit, a precipitation occurrence sensor, an air temperature/relative humidity sensor, an ultrasonic wind sensor, 2 wireless road surface sensors, a non-intrusive road surface condition sensor, a pan-tilt-zoom camera, and all mounting/attachment hardware, cables, test equipment, and manufacturer site commissioning necessary for a full and complete installation.

Remote Processing Unit (RPU)

The RPU shall gather, process, and store data from all connected atmospheric sensors, pavement sensors, and the camera. The data shall be transmitted to a centralized server upon polled request. The RPU shall utilize a Linux based operating system, and be capable of multi-tasking operations to optimize data acquisition from all connected devices. The RPU design shall maximize the use of solid-state components; no platter type drives or mechanized parts will be permitted. The RPU shall incorporate “watch-dog” circuitry and monitor its own operation and

reset itself if the RPU software enters an indeterminate state. The RPU shall also have the capability to be reset from the centralized server. The RPU shall include a minimum of two 10/100 Ethernet ports. The RPU shall include 20 differential and 11 single–ended channels. The RPU shall include ten serial ports configurable for RS-232 or RS-422/485 operating at full or half duplex from 300 to 115,200bps. All circuitry of the RPU, the voltage inputs, the sensor inputs, and the communications ports shall be designed and tested to provide transient and surge protection. The RPU shall include lightning protection for all channels and serial ports including auto-reset circuit breakers for power. The RPU shall operate in a range of 100-130 VAC at 50-60 Hz and shall use not more than approximately 60 Watts of continuous power.

The RPU shall have the capability of being modified to utilize solar power or other power sources in place of conventional commercial electric power. Solar powered RPU sites shall operate a minimum of 72 hours without sunlight or solar charging of the batteries. All RPU electronics shall be capable of operation over a minimum temperature range of -40°F to 160°F and 0-90% RH non-condensing. The RPU shall support full software configuration via a standard web browser. The RPU shall be capable of communication to the centralized server via serial RS-232/422/485 utilizing PPP or PMPP protocols or 10/100 Ethernet connection utilizing TCP/IP protocol. The RPU hardware and software provided shall be compliant with the most current Federal standard NTCIP ESS protocols.

At minimum the RPU shall be capable of collecting data from the following:

- 1 wired precipitation type sensor
- 1 wired air temperature/relative humidity sensor
- 1 wired ultrasonic wind speed/direction sensor
- 2 wireless in-pavement traffic/weather sensors
- 1 non-intrusive pavement condition sensor
- 1 wired pan-tilt-zoom camera

The RPU shall include an NEMA 4 rated lockable aluminum enclosure that is resistant to damage by weather and vandalism. The NEMA 4 enclosure shall be large enough to house all RPU electronics, power supplies, and communication equipment.

Precipitation Type Sensor

The precipitation sensor shall utilize optical, infrared technology to detect precipitation with beam interruptions by precipitation particles. The precipitation occurrence sensor shall sense the onset and cessation of precipitation in the form of rain, snow, sleet, and freezing rain and shall indicate when precipitation is occurring. The sensor shall provide any precipitation classification, measurements of intensity or water accumulation, as well as visibility. It shall provide proper operation over a minimum temperature range of -22°F to 140°F. The sensor shall operate to specifications at cable lengths up to 150 ft from the RPU.

Air Temperature/Relative Humidity Sensor

The Air Temperature/Relative Humidity Sensor shall have an air temperature-sensing element that operates within the temperature range of -40°F to 176°F. The relative humidity sensing should measure a range from 10 to 100% RH. The minimum operating temperature range shall be -31°F to 158°F. System dew point temperature shall be calculated from the air temperature

and relative humidity. The combined sensor shall operate to specifications at cable lengths up to 1000 ft from the RPU.

Ultrasonic Wind Sensor

The ultrasonic wind sensor shall measure wind speed and direction without any moving parts. The sensor shall be corrosion resistant and satisfy IP66 and IP67 ratings. The sensor shall include both 0 to 5000 mV analog and RS-232/RS-485 digital outputs. The sensor shall have an operating range of 0 to 145 mph, with a survival operation limit of 190 mph. Accuracy for measured wind speed shall be less than 3% of actual wind speed. Wind speed direction operating azimuth shall be measurable from 0 to 360°, with an accuracy of +/- 2°, and resolution of 1°. The minimum operating temperature range shall be -40° to 140°. The sensor shall include provisions to deter animal perching or nesting. The sensor shall operate to specification at cable lengths up to 30ft from the RPU, and include all mounting hardware.

Wireless Road Surface Sensor

The wireless road surface sensor shall detect road surface temperature, sub surface temperature, provide a wet, dry, trace moisture, chemical wet, or ice watch status reading along with a chemical percent index. The sensor shall also utilize magnetic imaging to provide accurate vehicle count, speed, and classification data. All data shall be transmitted wirelessly to the RPU utilizing the ISM 902 - 928 MHz band with a minimum transmission range of 300 ft. The sensor shall utilize external sensors to measure both pavement and sub-surface temperatures. The sensor shall be powered from a Lithium thionyl chloride battery and operate in a minimum range of -40ºF to +185ºF. The sensor shall be self contained and removable to allow for battery replacement. The sensor shall include compatible wireless receiver for data transmission to the RPU.

Non-Intrusive Pavement Condition Sensor

The non-intrusive pavement condition sensor shall utilize Class 1 Laser technology to accurately measure presence of water, ice, slush, snow, or frost. The sensor shall also measure the level of grip or friction coefficient of the roadway. The sensor shall be powered from a 9 - 30 VDC source and use no more than 4 watts of power. The sensor shall operate in a minimum temperature range of -40 to 140 °F at 0 to 100% RH. The sensor shall be capable of accurate measurements at distances of 10-40ft from the roadway. The sensor shall provide RS-232 and RS-485 serial data communication interfaces and be capable of operation on cable lengths up to 300 ft from the RPU. The Contractor is responsible for ordering the correct cable length based on planned installation. If the weather monitoring system is greater than 25ft from the white edge line of the roadway being measured then the non-intrusive pavement condition sensor shall include breakaway pole that is 27ft above ground height

Pan-Tilt-Zoom Camera

The pan-tilt-zoom camera shall be of dome type construction and be capable of gathering a minimum of 50 preset color video still frame images with a minimum 176x120 resolution and maximum 704x480. The camera shall be enclosed in a sealed, heated, pressurized environmental video dome housing to operate in 100% humidity at a minimum operating temperature of -40° to 122°F carrying both IP66 and NEMA 4x ratings. The camera shall provide dual mode, day (color) and night (monochrome) video down to 0.008 lux. The lens shall

be f=3.4 – 119mm, F1.4 – 4.2, autofocus; focus range of 35 mm(wide) to 800 mm (telephoto) to infinity. The angle of view shall be 2.8°-48° horizontal with minimum zoom capability of 35x optical, 12x digital. Minimum illumination color 0.5 lux at 30 IRE and B/W 0.005 lux at 30 IRE. The pan function shall provide 360° of continuous rotation at 0.05 – 450°/s and a 220° tilt range allowing for 20° view above the horizon at 0.05 – 450°/s. Shutter speed shall be variable from 1/30000 – 0.5 seconds at 60Hz. The camera shall utilize Ethernet protocol for native communications and be capable of sending multiple individually configurable video streams in H.264 and MJPEG format up to 30fps. The camera shall have an internal web interface for configuration with security functionality allowing multiple user access levels with password protection. The camera shall support IPv4/v6, HTTP, HTTPS, SSL/TSL, QOS Layer 3 DiffServ, FTP, SMTP, SNMP v1/2/3, UPnP, DNS, DynDNS, NTP,RTSP, TCP, UDP, IGMP, RTCP, ARP, and SOCKS.

CONSTRUCTION REQUIREMENTS

The Contractor shall install the WMS in accordance with the WMS vendor's recommendations, CDOT plans and Standard Specifications and all federal, state and local codes and requirements. The Contractor will be responsible for providing all traffic control/safety work zones for the installation of the roadway sensors in accordance with the CDOT traffic control requirements.

The Contractor shall install a 120VAC electrical supply from the power source to a location near the RPU. The Contractor shall connect the 120VAC service to the RPU power disconnects. The primary power should be installed to the RPU and fused for 20 amps, with voltage surge protection. The Contractor shall install the RPU electronics enclosure on the fold over tower per manufacturer recommendations.

The precipitation type sensor shall be mounted on the WMS tower per manufacturer's recommendations above ground level at the RPU.

The air temperature/relative humidity sensor shall be mounted on the WMS tower per manufacturer's recommendations at the standard meteorological height of approximately 6 feet above ground level in a UV stabilized white thermoplastic solar/wind-radiation shield.

The ultrasonic wind sensor shall be mounted on the WMS tower per manufacturer's recommendations at the standard meteorological height of approximately 30 feet above ground level at the top of the WMS tower. The sensor shall be mounted such that birds are not able to perch or nest on the sensor.

The wireless in-pavement traffic/weather sensors shall be installed per manufacturer's recommendations after the top layer of pavement has been completed. One sensor will be installed in each lane of travel. Exact sensor placement shall be as determined by the Project Engineer with guidance from the equipment supplier.

The non-intrusive pavement condition sensor shall be mounted on the WMS tower per manufacturer's recommendations at a height and angle that will allow measurement of the middle of the closest lane of travel. If the WMS is greater than 25ft from the white edge line of the roadway being measured then the sensor shall be mounted on a fiberglass pole installed 15feet from the same white edge line. Conduit and pull boxes shall be installed between the WMS and pole to connect the sensor to the WMS RPU.

The pan-tilt-zoom camera shall be installed per manufacturer recommendations on the WMS tower approximately 27 feet above ground level and configures for a minimum of two preset positions as determined by the Project Engineer.

Cables for all sensors and the camera shall enter through the bottom of the NEMA 4 enclosure and connect to the RPU electronics.

The Contractor is responsible for connecting the WMS to communication infrastructure provided by the project where applicable.

After completion of the equipment installation, the equipment manufacturer representative shall perform all final system checks, sensor alignments, sensor setup, RPU configuration including site communication setup, and central server configuration to provide a fully operational WMS.

The existing CDOT owned WMS server utilizes the Windows Server 2003 Operating System, and will collect sensor data from all RPUs in the system, including this new site. The CTMC server will poll the RPU to ask for data on a preset time interval, typically every 10 minutes, or as specified by CDOT to transfer and refresh its data. CDOT users will access the WMS data via any PC running a commercial web browser which is connected to the CDOT statewide WAN.

Any associated hardware not listed that is considered subsidiary and is required for a complete installation shall be included as part of the work.

See project specific Testing & Integration Plan for additional requirements.

WARRANTY

The Contractor shall ensure that the manufacturer can warranty the product for a minimum of 1 year for all parts returned to the factory and 1 year telephone technical support at no additional charge to the Department. The technical support shall include access to a trained service representative who can respond within 24 hours to questions related to all WMS related equipment problems and maintenance issues. This one-year service shall also include an eight (8) hour training session for CDOT staff.

APPENDIX 19-B
TESTING AND INTEGRATION PLAN

1.0 Introduction

The scope of this document includes the testing and integration of all new devices, reset devices, and existing devices connected to the fiber optic backbone on the C470 Design/Build Project (Project) within the Project limits.

Integration and testing shall be conducted for all Project elements that meet any of the following criteria:

- A new device and/or cabinet supporting the device has been installed or relocated.
- The communications path between the devices and the local cabinet has been disturbed and/or relocated.
- A new communication path to a device has been established.

1.1 Roles and Responsibilities

1.1.1 The Contractor

The Contractor shall install, configure, and test all new Intelligent Transportation System (ITS) devices and fiber communications throughout the Project corridor. The Contractor will be responsible for providing the appropriate notice to the Colorado Department of Transportation (CDOT) ITS and submitting all test results and as-built documentation. The Contractor shall include notification periods, testing periods, and burn-in time in their overall project schedule.

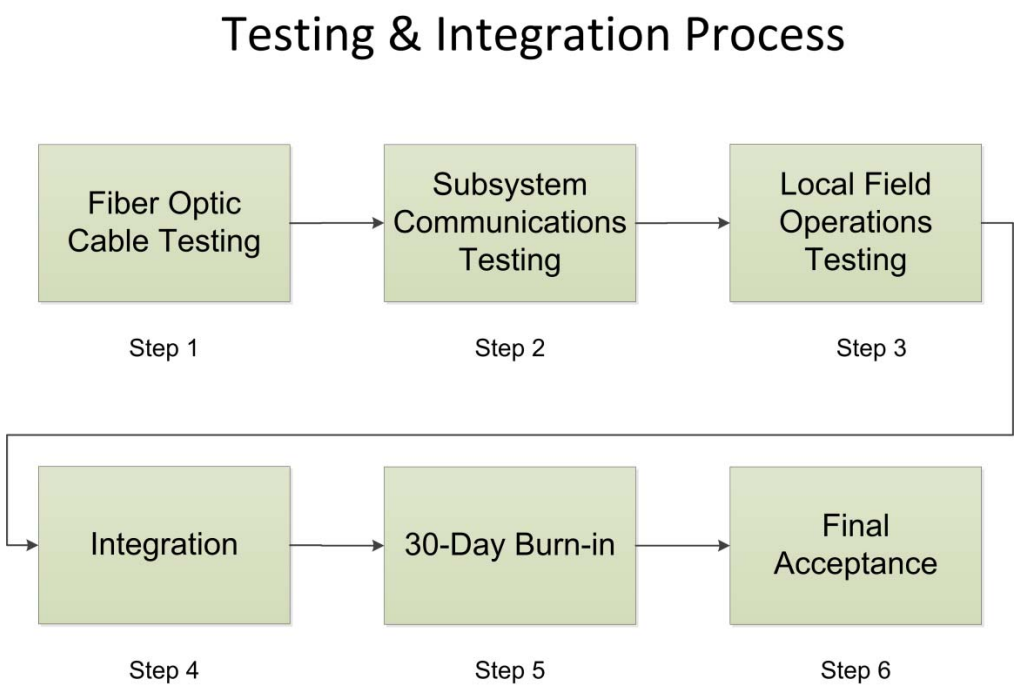
1.1.2 E-470

E-470 will install and test devices related to the Electronic Toll Collection (ETC) system per their own Testing and Integration Plan.

1.1.3 CDOT ITS

CDOT ITS will be responsible for providing Internet Protocol (IP) address ranges for all devices, configuring all switches and routers, integration efforts on the Colorado Transportation Management Center (CTMC) side, and configuration of server and software settings. Specific responsibilities for each device are included in Section 2.0 of this document. CDOT ITS or their designated representative will be responsible for witnessing and signing off on all testing.

1.2 Flow Chart



1.3 Notification Timelines

Item Requiring Notification	Required Notice Period	Notes
Fiber Splicing	Contractor shall notify the Project Engineer and CDOT ITS two weeks prior to performing the work, as well as one week advance notice of any fiber optic backbone cutover work	
Subsystem Communications Testing	Contractor shall notify the Project Engineer and CDOT ITS 7 days in advance	Performed in conjunction with CDOT ITS
Electronic Sign Commissioning	Contractor shall notify the Project Engineer and CDOT ITS two weeks in advance	Performed by manufacturer representative
Local Field Operations Testing	Contractor shall notify the Project Engineer and CDOT ITS two weeks prior to the test date for each site	Upon notification, Contractor must submit Form 1411
Integration	Contractor shall notify the Project Engineer and CDOT ITS 7 days prior to when they would like CDOT to begin integration	

2.0 Testing Procedures

2.1 Fiber Optic Cable Testing

Test Fiber Optic Cable shall include Optical Time Domain Reflectometer (OTDR) tests, Coarse Wave Division Multiplexor (CWDM) OTDR tests, spectrum analysis of CWDM fiber, and optical power meter tests of all installed fiber and modified existing fiber on the project.

The Contractor shall use equipment that is calibrated twice per year. A copy of the most recent certificate of calibration and all out-of-tolerance conditions shall be provided to the Project Engineer prior to the initiation of testing activities. The following equipment and information is required to perform fiber optic cable tests:

(1) An OTDR (submit certification to Project Engineer)

(2) A Coarse Wave Division Multiplexor OTDR (submit certification to Project Engineer)

(3) An optical spectrum analyzer (submit certification to Project Engineer)

(4) Optical Power Meter Equipment capable of measuring optical power in dBm (submit certification to Project Engineer)

(5) A launch box (min length – 1000 feet)

(6) A light source at the appropriate wavelength

(7) Test jumpers shall be 3 feet to 12 feet long with connectors that are compatible with the light source and power meter and shall have the same fiber construction as the link segment being tested.

Prior to splicing and testing on the project the Contractor shall submit a detailed Method Statement to the Project Engineer describing the splicing and testing plan and schedule. Discussion of the Contractor's Device Cutover Plan and a proposed Device Cutover Schedule shall be included in the Method Statement. No fiber optic splicing shall begin until the Method Statement is submitted and approved. If at any time it is determined that work began without an approved Method Statement, or the work is not following the approved Method Statement, an immediate "stop work" order will be issued and work will not resume until the Method Statement has been submitted and approved. Once the splicing and testing begins, the Method Statement shall be updated if necessary to address any changes in the original planned and approved procedures.

The Contractor shall conduct fiber optic testing at the following stages:

(1) Pre-installation testing – bi-directional OTDR test of every fiber on every reel after delivery of the reel

(2) Post installation and pre-splicing test – bi-directional OTDR test of every fiber of every cable after fiber is installed in the ground

(3) Post-splicing tests, pre-CWDM filter splicing tests

i) Optical Power meter test from all fiber terminated in communications cabinets to a network facility for all fiber that is not used for CWDM on the project.

ii) Bi-directional OTDR test of all fiber between termination point in a network facility and cable end and between termination point in a network facility and communications cabinets for fiber that is not used for CWDM on the project
iii) Bi-directional CWDM OTDR test of all fiber between termination point in a network facility and cable end and between termination point in a network facility and communications cabinets for all fiber that is used for CWDM on the project

(4) Post-CWDM filter splicing tests

i) Spectrum analysis of all terminated fiber used for CWDM after filters have been spliced
ii) CWDM-OTDR
iii) Optical Power meter test and documented attenuator values

(5) Re-testing of all stages above if initial test fails and after corrective action is taken

The guidelines for fiber optic cable testing include:

(1) Launch box and test jumpers must be of the same fiber core size and connector type as the cable system: Single mode fiber 9.0μm (nominal) /125 μm

(2) The light source and OTDR must operate within the range of 1310±10 nm and 1550±20 nm single mode nominal wavelength for testing in accordance with Telecommunications Industry Association (TIA) TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.

(3) The power meter and the light source must be set to the same wavelength during testing.

(4) The OTDR and power meter must be calibrated at each of the nominal test wavelengths and traceable to the National Institute for Standards and Technology (NIST) calibration standards.

(5) The calibration of the OTDR and power meter shall conform to the requirements set forth in Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA) TIA/EIA-455-226 Calibration of Optical Time-Domain Reflectometers and TIA-455-231 Calibration of Fiber Optic Power Meters, respectively.

The Contractor shall document jacket length measurements for lateral and backbone cable at each end including splice enclosures and patch panels, and at any intermediate splice points.

The Contractor shall document bare fiber slack not accounted for in jacket length.

All system connectors, adapters and jumpers shall be cleaned per manufacturer's instructions before measurements are taken.

At locations of new lateral fiber optic cable installation and at locations that require the re-installation of existing lateral fiber optic cable, the Contractor shall conduct testing from the termination panel mounted in the communications cabinet to the splicing manhole. The bi-directional test shall be conducted from the termination panel towards the splicing manhole and from the splicing manhole to the communications cabinet termination panel.

Final splicing will not begin until such time that the Contractor submits OTDR test results to the Project Engineer and the Project Engineer reviews the results.

Final OTDR testing from the communications cabinet to the corresponding node building shall be conducted after their splicing work has been completed. All issues with communications related to Contractor installation and workmanship shall be remediated by the Contractor at no additional cost to the project.

A functional test shall be made in which it is shown that each and every part of the system functions as specified or intended herein.

(f) Optical Fiber Cable Testing with OTDR

The Contractor shall perform an OTDR test of all fibers in all tubes on the reel prior to installation of the fiber. The test results shall be supplied to the Project Engineer prior to installation of the cable.

Fiber testing shall be performed on all terminated fibers from patch panel to patch panel and unterminated fibers from end to end. Additionally, mid entry splices into mainline cables require testing of all strands in the mainline cable before and after installation. Testing shall consist of a bi-directional end-to-end OTDR trace.

Loss numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two.

The Contractor shall use an OTDR that is capable of storing traces electronically and shall save each final trace.

The Contractor shall use a test reel of minimum length identified in the Materials section of this Special Provision. The Contractor shall indicate the length of the test reel, in feet, for all test results.

If the fiber designation is not indicated on the trace itself, the Contractor shall provide a cross-reference table between the stored trace file name and the fiber designation.

The Contractor shall record the following information during the test procedure:

(1) Name and contact information of person conducting the test

(2) Type of test equipment used (manufacturer, model, serial number, calibration date and valid certification of calibration)

(3) Date test is being performed

(4) Optical source wavelength and spectral width

(5) Fiber identification

(6) Start and end point locations

(7) Test direction

(8) Launch conditions

(9) Method of calculation for the attenuation or attenuation coefficient

(10) Acceptable link attenuation

(11) Cable manufacturer stated index of refraction for cable being tested

(12) Jacket readings in and out of each splice vault and each pull box

(g) Optical Fiber Cable Testing with Optical Power Meter

The Contractor shall conduct an Optical Power Meter Test of each fiber installed.

Single mode segments shall be tested in one direction at both the 1310 nm and 1550 nm wavelength.

The following information shall be recorded during the test procedure:

(1) Names of personnel conducting the test

(2) Type of test equipment used (manufacturer, model, serial number, calibration date and a valid certification of calibration)

(3) Date test is being performed

(4) Optical source wavelength and spectral width

(5) Fiber identification

(6) Start and end point locations

(7) Test direction

(8) Reference power measurement (when not using a power meter with a Relative Power Measurement Mode)

(9) Measured attenuation of the link segment

(10) Acceptable link attenuation

(h) Acceptable Attenuation Values

The Contractor shall calculate acceptable attenuation values for each fiber tested. These values represent the maximum acceptable test values.

The general attenuation equation for all single mode link segments is as follows:

Acceptable Link Attenuation = Cable Attenuation + Connector Attenuation + Splice Attenuation.

8.3 μm (nominal) Single-mode Attenuation Coefficients:

(1) Cable Attenuation=Cable Length (km) x (0.35 dB/km at1310 nm and 0.22 dB/km at1550 nm)

(2) (No. of Mated Connections x 0.50 dB)

(3) Splice Attenuation = Splices x 0.30 dB

(i) Test Procedures

The single mode Optical Power Meter fiber test shall be conducted in accordance with TIA-526-7.

The single mode OTDR test shall be conducted in accordance with TIA-526-7.

Testing for CWDM single wavelength filters (CWDM filter) shall be conducted in the following manner to ensure that the filter Pass, Reflect and Common pigtails are spliced to proper lateral fiber strands. Testing procedures and CWDM data flow information is included on the plans. Testing shall be conducted for all CWDM wavelengths applicable to each fiber strand used for data communications. CWDM wavelengths on this project are expressed in nanometer (nm) and include 1430 nm, 1450 nm, 1470 nm, 1490 nm, 1510 nm, 1530 nm, 1570 nm, 1590 nm, and 1610 nm. Industry standard wavelengths (e.g. 1430 nm = 1431 nm) shall be observed.

After completion of fiber optic cable installation and prior to the CWDM filter splicing, all backbone cable to lateral cable splices shall be completed in the individual Ethernet switch sub-rings. Required steps shall include:

(1) The backbone end of Lateral Cable 1 shall be spliced to the fiber optic backbone cable in Splice Closure 1. Once this splice is complete no future access to Splice Closure 1 shall be made unless a re-splice is required.

(2) The opposite end of Lateral Cable 1 shall be spliced to itself in Splice Closure 2 in a manner to achieve continuity in the backbone strands from the beginning of the sub-ring (first node building) to the far end of the sub-ring (next node building).

(3) An OTDR test shall be conducted on the sub-ring from building to building to ensure proper splicing of Lateral Cable 1 in Splice Closure 1.

Once the OTDR test is complete the results shall be submitted to the Project Engineer for approval. After approval the splicing of CWDM filters in Splice Closure 2 may begin.

The Contractor shall be required to break the Lateral Cable 1 splices in Splice Closure 2 used in the continuity test and conduct the CWDM filter splicing per the project fiber splice plans. This will include splicing of Lateral Cable 1 and Lateral Cable 2 in Splice Closure 2 and the termination of Lateral Cable 2 in the communications cabinet.

After CWDM filter splicing, the Contractor may use one of the following methods to ensure the proper CWDM filter splicing.

(1) By using a fiber identifier, testing of the incoming signal from either the upstream or downstream CWDM location, the Contractor shall show the Project Engineer that proper CWDM filter pigtail splicing has been achieved.

(2) By using a spectrum analyzer to test the incoming wavelength to ensure proper splicing and wavelength of the CWDM signal.

Once all splicing of the individual sub-ring is complete the Contractor shall conduct the CWDM-OTDR and spectrum analyzer testing and submit the results to the Project Engineer. At the acceptance of these tests, the Contractor shall determine the proper optical attenuator to install in the Receive (RX) ports at both the communications termination panel and the node building termination panel. After installation one final test of optical power shall be conducted to determine if the proper signal strength is being achieved by the Ethernet switch CWDM optic.

At that point the Colorado Department of Transportation, Colorado Transportation Management Center personnel along with Ciena network engineers will configure the sub-ring into the overall CDOT ITS network. If network communications cannot be achieved, a review of the CWDM testing materials will begin.

(j) Test Acceptance

The Contractor shall demonstrate that the tests result in acceptable attenuation values.

The Contractor, solely at the Contractor's expense, shall re-splice all fusion splices and re-terminate all terminations that have test results exceeding acceptable attenuation values. The Contractor, solely at the Contractor's expense, shall retest all fiber links that have been re-spliced and shall retest all fiber links that have been re-terminated.

The Contractor, solely at the Contractor's expense, shall bring all links not meeting the requirements of this specification into compliance.

(k) Submittals

The Contractor shall submit test result documentation as both a hard copy and electronic copy.

After each reel test, the Contractor shall submit one hard copy of the OTDR trace for every fiber on the reel.

After installation, the Contractor shall submit two hard copies and one electronic copy of the following tests:

(1) Continuity OTDR trace for every spliced fiber which the CWDM optical network will utilize.

(2) OTDR trace for every fiber the high speed DWDM optical network will utilize.

(3) CWDM-OTDR trace for every fiber which the CWDM optical network will utilize.

(4) Spectrum analyzer test results for every fiber which the CWDM optical network will utilize.

(5) OTDR traces and power meter results for all "dark" unused fiber strands in the backbone fiber optic cable from node buildings.

Hard copy traces shall be organized and bound in logical order in an 8 ½ inch x 11 inch hard cover binder.

The Contractor shall submit, after approval of the hard copy traces, electronic copies of all traces (PDF and native file format) and appropriate software, if needed, to allow reading the traces.

The Contractor shall submit one copy of the complete contract Plans, including additional drawings issued as part of all change orders, with all deviations clearly marked in color. Deviations to be noted shall include at a minimum, but not be limited to, the following:

(1) Fiber Splice location

(2) Fiber Splice configuration

(3) Termination layout

After all splicing and fiber optic testing is completed the Contractor shall test the optical power of the incoming, (Receive) signal at each field Ethernet switch and existing node building location. To obtain the most accurate values of optical power, the testing equipment shall be attached to the SFP optic end of the pre-connectorized patch cable.

Once the optical power has been tested, the Contractor shall install the appropriate attenuator in the receive port to meet the receive values of the SFP optic module, including a design margin of 6 dB (to allow for degradation over the life of the system).

2.2 Subsystem Communications Testing

2.2.1 Description (CDOT performs this work)

A subsystem communication throughput test over the communication path between each field device and the node building shall be performed. The testing shall occur after all communication installation for a particular site has been completed, the communication paths between the device and the node building have been functional for at least 48 hours, and all fiber optic tests have been successfully passed.

CDOT has testing procedures for certain devices as outlined in Section 2.2 Local Field Operations Testing. For all other elements, the Contractor shall develop a test plan for conducting system and subsystem testing and submit it to CDOT for Approval. No testing shall be performed until CDOT has approved the test plan. A CDOT staff member or an authorized CDOT representative must witness and sign off on all tests.

2.2.2 Prerequisites for CDOT Testing

Prior to CDOT performing the Subsystem Communications Testing, the Contractor shall ensure that local field operations testing is complete, including network connectivity tests.

2.2.3 Scheduling Requirements

The Contractor shall notify the Project Engineer and CDOT ITS at least seven days prior to when they would like CDOT to begin testing. CDOT may adjust the proposed testing schedule by up to seven days, at no cost to CDOT, to accommodate availability of personnel. CDOT shall be provided two weeks to complete their Subsystem Communications Testing and, if CDOT completes their Subsystem Communications Testing within these timeframes, no time extensions or schedule allowances will be granted to the Contractor.

2.3 Local Field Operations Testing

Local Field Operations Testing shall be conducted to demonstrate that all hardware, cables, and connections furnished and installed by the Contractor operate correctly and that all functions are

in accordance with the requirements described in the specifications, manufacturer's recommendations, and this document. When Local Field Operations Testing is scheduled at a specific site, all devices on an Ethernet switch at that site shall be tested simultaneously.

2.3.1 Documentation

The Contractor shall maintain their own tracking and documentation of the testing procedures on the Project. This documentation shall be maintained at a minimum on a weekly basis and the Contractor shall be able to provide CDOT with the latest version of their documentation upon request at any time once testing procedures have begun on the Project. At a minimum, the documentation shall include, by device, the date that the pretest notification was given to CDOT, the date that the device data sheets were submitted to CDOT, the date that preliminary testing of a device was complete by the Contractor, and the date that Local Field Operations Testing was complete.

The Contractor shall notify the Project Engineer and CDOT ITS at least two weeks prior to the test date for each site. This notification shall contain the Device Information Sheet and be provided to the CDOT ITS in Golden, CO. The Device Information Sheet submittal shall include photos. The Contractor shall also notify the Project Engineer and CDOT ITS upon test completion.

The Contractor shall provide device commissioning sheets from each device manufacturer, as required herein. The Contractor shall submit any additional testing documentation or requirements as required by the individual device specifications.

2.3.2 General Testing

Testing for each device shall include confirming physical location, verifying proper orientation of all devices, checking for physical access to the cabinet, voltage testing, local communication connectivity testing, grounding, proper cable management, and device-specific function testing as described in the following sections. It shall be demonstrated that all hardware, cables, and connections furnished and installed by the Contractor operate correctly and that all functions are in accordance with the requirements described in the specifications, manufacturer's recommendations, and this document. The tests shall include all items addressed in the specifications, manufacturer's recommendations, and this document. Local communication connectivity testing will ensure communication between each device and the respective local switch or modem, and a link to the nearest node building aggregation switch. Power and communications are required in order to schedule the acceptance of a site.

The Project Engineer and a CDOT ITS representative shall witness and sign off on all tests. Prior to performing local operations testing with a CDOT staff member or an authorized CDOT representative, the Contractor shall run through the local operations testing themselves. If the site is not fully configured, functional, and ready for testing when the CDOT staff member or authorized CDOT representative is there, the test date will be rescheduled with the notification periods starting over.

After completion of device specific testing and communication with the respective gateway at the CTMC is confirmed, the Contractor shall notify the Project Engineer and CDOT ITS that the device is ready for integration into the head-end control system. All modifications to the head-end control system will be performed by CDOT ITS.

2.3.3 Site Grounding

The Contractor shall verify the installation of the grounding system at each site. This test will ensure that the system has been installed per the specifications and this document. The test will also require the technician to verify that all devices are properly grounded and that all conductors have been terminated.

Testing shall be performed prior to connecting to utility ground in an effort to eliminate ground loops. When the grounding electrodes are installed, they shall be measured for their effectiveness using the three-point, fall of potential method per IEEE 81 to measure the resistance of the installed grounding electrode configuration with respect to the surrounding soil using an earth ground resistance tester. The final measurement must be performed in the presence of the Engineer or CDOT's designated representative. The Contractor shall provide documentation to the Engineer of ground grid measurement results for each ITS site location tied to a single grounding system.

Contractor shall furnish its own earth ground resistance tester including stakes, clamps, cabling, transformers, and other required accessories needed to perform the testing. A copy of the earth ground resistance tester's NIST certification shall be provided to the Engineer as verification that the unit has been calibrated using standards and instruments traceable to international standards.

See Attachment B for required Site Grounding testing form.

2.3.4 Location Specific Testing

2.3.4.1Cabinets

The Contractor shall verify installation of all cabinet equipment. The power supply voltages and the functionality of the cabinet fans and heaters shall be verified.

See Attachment B for required cabinet testing forms.

2.3.4.2 Dynamic Message Signage

The Contractor shall perform a Dynamic Message Sign (DMS) acceptance test procedure for approval and acceptance by CDOT in the presence of the Engineer, a representative of the CDOT CTMC, and the manufacturer's representative. The test shall include the use of the latest version of the NTCIP Exerciser, or equivalent, to demonstrate that no proprietary protocols have been used and that the local and central software are NTCIP compliant.

All DMS shall be fully commissioned by the manufacturer. This documentation, including all manufacturers' testing and commissioning forms, shall be submitted to CDOT. The Contractor shall submit a "*DMS Commissioning Procedure*" for each type of DMS included in the project for Acceptance by CDOT. The test procedure shall be performed in the presence of CDOT and the manufacturer's representative. The Contractor shall notify the Project Engineer and CDOT ITS at least two weeks prior to the test date.

See Attachment B for required DMS testing forms.

2.3.4.3 Closed Circuit Television Camera and Lowering Device

Testing of each Closed Circuit Television (CCTV) Camera shall include checking the functionality and performance of the camera lowering pole including successfully raising and lowering the camera three times. Other devices on the camera lowering pole must not interfere with the operation of the lowering system. The tester will then need to verify that a local connection can be made through the assigned IP address. Once connected to the web Graphical User Interface (GUI), the tester will need to verify streaming video in both JPEG and H264 formats. The tester will verify the camera field of view is completely free of obstructions. Next, the tester will need to ensure the Pan/Tilt/Zoom functions in accordance with the specifications, manufacturer's recommendations, and this document.

See Attachment B for required CCTV Camera testing forms.

2.3.4.4 Ramp Meter System

The Contractor shall confirm full operation of all flashing beacons and signal heads. The Contractor shall verify communications are properly functioning for the passage, demand, and queue detection. The Contractor shall then observe traffic for each lane for a period of ten minutes to ensure each sensor is reading and communicating the traffic passing over it. The Contractor shall also monitor operation of the ramp meter for a three day period during operational time slots to ensure proper function of the RMS. Detailed documentation of all observations shall be recorded and submitted to CDOT for review.

The Contractor shall confirm communication between the controller and the Microwave Vehicle Radar Detector (MVRD) that is performing mainline detection. The Contractor shall perform MVRD testing for all RMS related MVRDs per the following Section of this document.

See Attachment B for required RMS testing forms.

2.3.4.5 Microwave Vehicle Radar Detector

The Microwave Vehicle Radar Detector (MVRD) test shall include ensuring proper alignment of the radar head to the lanes of traffic it is detecting. The Contractor shall then verify the proper cabling and termination of all cables between the radar head and all interfacing click modules. The Contractor shall then use the SSD HD V2.0.6 software to connect to the assigned IP address of the Click! 301. Within the SSD HD software, the Contractor shall verify correct setup of bin definitions and lane setup by observing traffic flow. The Contractor shall perform testing to verify the accuracy of volume, occupancy, and speed readings per the MVRD testing forms.

See Attachment B for required MVRD testing forms.

2.3.4.6 Travel Time Indicator

Preliminary alignment of antennas shall be verified during installation by placing a wooden box with a toll tag affixed to a Plexiglas lid that represents a windshield. All physical cabling connections including the RF cable connections shall be verified. All RF cables shall be tested to measure dB loss. A laptop shall then be connected to the Ethernet surge suppressor to ensure the local IP settings are correct by connecting to the 3M web GUI. Once logged in, the Contractor shall check that all appropriate licenses are installed and the proper version of the Python application is running. At this time testing shall commence per the TTI testing form to confirm the performance and accuracy of the TTI antennas. Testing shall be measured as 90% vehicle transponder detection. Testing shall include a full data path to the TTI and acceptance by CDOT.

See Attachment B for required TTI testing forms.

2.3.4.7 DTD ATR

For the DTD Automatic Traffic Recorders (ATR), acceptance shall be based on the testing and operation of the Wavetronix SmartSensor and Phoenix Diamond Counter (for the temporary ATR) and will be based on the testing and operation of the piezos and loops (for the permanent ATR) under actual traffic conditions, in which one week of actual data will be collected. The volume and vehicle class shall be within ±10 percent for the site compared to historical data for the test period. There shall be no more than one percent sensor misses in any one lane for the same time period.

The Contractor shall verify the correct operation of this equipment in conjunction with CDOT's Mike DelCupp to ensure proper reading of the traffic, correct configuration of the Phoenix Diamond Counter, and verify communication back to CDOT's ATR server via the existing telephone lines.

The piezo shall be tested for capacitance and dissipation factor prior to and after installation using an LCR meter. Capacitance and dissipation shall be within ±20 percent of the data sheet supplied with the piezo. Prior to acceptance of the site, the TDC will test the piezo for voltage and signal quality with live traffic. Voltage shall be no lower than 80 millivolts on the front axles of a class II vehicle (car).

Prior to sealing the loop, loop lead and feeder slots, a loop continuity test shall be performed. The test shall be performed by the TDC representative. Loop continuity shall be no higher than 1 ohm. Loop continuity higher than 1 ohm shall be cause for replacement of the loop. Replacement shall be at the Contractor's expense.

See Attachment B for required DTD ATR testing forms.

2.3.4.8 Road Weather Information Systems

The Contractor shall perform the CCTV Camera tests described herein for the RWIS camera. The vendor shall complete the commissioning process. After commissioning, the Contractor shall verify communication of the RWIS controller back to the RWIS server at the CTMC.

After completion of the equipment installation, the equipment manufacturer representative shall perform all final system checks, sensor alignments, sensor setup, RPU configuration including site communication setup, and central server configuration to provide a fully operational RWIS.

Additionally, all RWIS shall be fully commissioned by the manufacturer. This documentation, including all manufacturer's testing and commissioning forms, shall be submitted to CDOT.

See Attachment B for required RWIS testing form.

2.4 Integration

2.4.1 CTMS and CDOT's Camera Software Integration

2.4.1.1 Description

CDOT ITS will be responsible for modifying the CTMS and CDOT's camera software to integrate all local devices within the Project corridor.

2.4.1.2 Prerequisites for Integration

Once local field operations testing is complete for a device, the Contractor shall notify the Project Engineer and CDOT ITS that the device is ready for integration into the CTMS software, as well as CDOT's camera software for CCTV Cameras.

2.4.1.3 Scheduling Requirements

Once the fiber optic backbone cable has been installed, the Contractor shall contact the Project Engineer and CDOT ITS to schedule an Integration Kick-Off Meeting.

The Contractor shall notify the Project Engineer and CDOT ITS at least seven business days (excluding state holidays) prior to when they would like CDOT to begin CTMS and CDOT's camera software integration. CDOT may adjust the proposed integration schedule by up to seven days, at no cost to CDOT, to accommodate availability of personnel. CDOT shall be provided three weeks to complete their CTMS and CDOT's camera software integration and, if CDOT completes their work within these timeframes, no time extensions or schedule allowances will be granted to the Contractor.

2.4.2 Toll System Integration (E-470)

2.4.2.1 Description

A toll point is defined as a single toll collection point for one direction of travel. E-470 will be responsible for installing and integrating all ETC equipment at each toll point. E-470 will also be responsible for lane testing of the ETC equipment and final acceptance testing.

2.4.2.2 Prerequisites for E-470 Integration

Prior to E-470's work to install and integrate all ETC equipment at each tolling location, the Contractor must have performed all fiber and power testing to the toll locations, utilizing the testing procedures described herein to confirm functionality of the toll cabinets and lateral fiber. See Section 19.3 of the RFP for additional requirements.

2.4.2.3 Scheduling Requirements

See Section 19.3 of the RFP for requirements regarding scheduling and coordination with E-470.

2.5 Thirty Day Burn-in Test

2.5.1 Description of Test

After successful completion of all subsystem test procedures, the Contractor shall notify the Project Engineer and CDOT ITS that the 30-day burn-in test is ready to begin. All devices that are new, reset, or existing and connected to the fiber optic backbone within the Project corridor shall be included in the 30-day burn-in test. Each site shall be tested for proper functionality and device availability for 30 consecutive days. The test shall be performed per the specifications, manufacturer's recommendations, and this document. During the testing period, all equipment at the site that was provided, installed, or relocated by the Contractor shall operate without failures of any type. The Contractor shall coordinate with CDOT ITS for maintenance repair request tickets. Within 24 hours of notification by CDOT of a faulty component or device, the Contractor shall troubleshoot to find the exact cause of the failure and correct any fault. The cost of correcting equipment malfunctions shall be the responsibility of the Contractor. After the component malfunction has been corrected to the satisfaction of CDOT, the 30-day test period shall be start over.

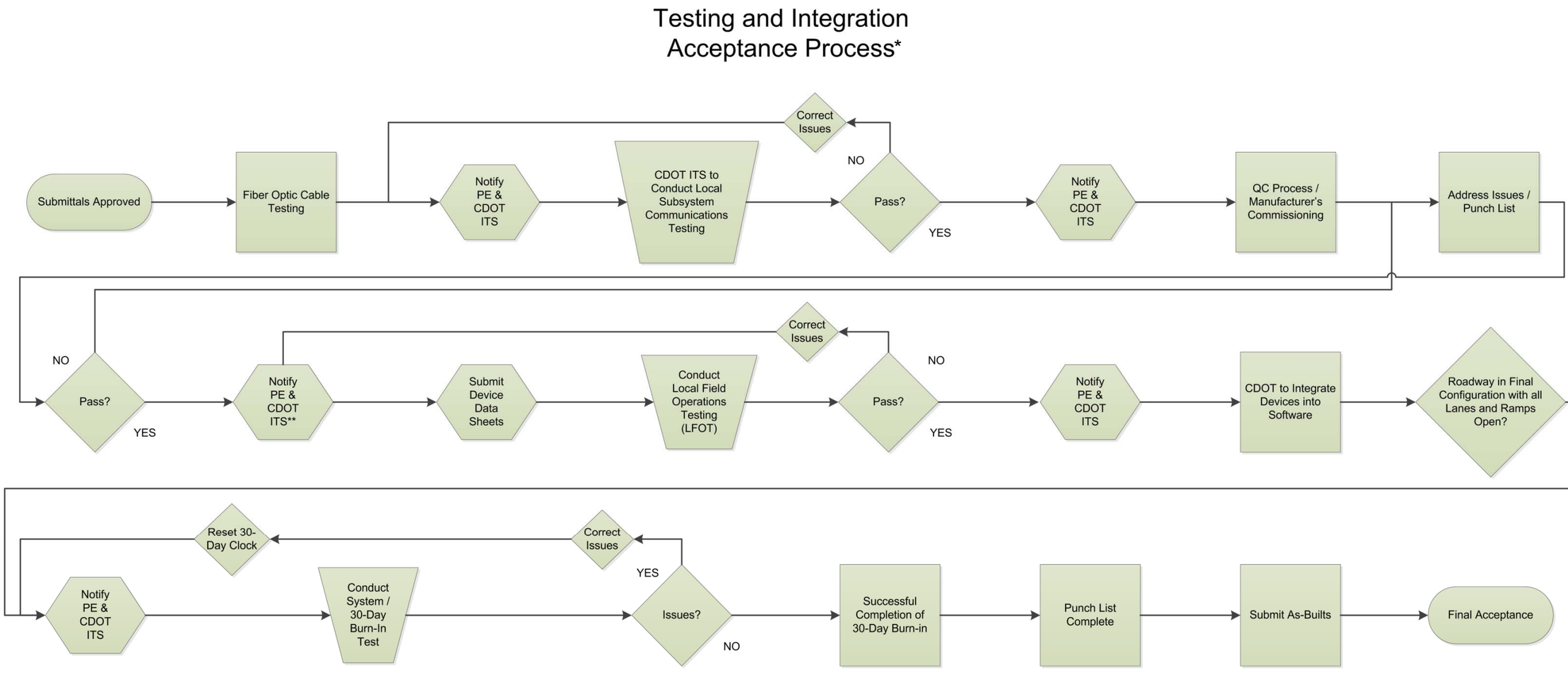
2.5.2 Acceptance Procedures

Documentation indicating successful passing of each test shall be submitted to CDOT for review prior to Project Final Acceptance.

2.5.3 Documentation

The Contractor shall maintain their own tracking and documentation for the progress of the 30-day burn-in test. This documentation shall be maintained at a minimum on a weekly basis and the Contractor shall be able to provide CDOT with the latest version of their documentation upon request at any time once the 30-day burn-in testing period has begun on the Project. At a minimum, the documentation shall include the date that the 30-day burn-in testing originally began, the date and time of any equipment malfunctions within the corridor, and the date and time that the Contractor restored functionality of any equipment that failed (marking the restart of the 30-day test period).

3.0 Testing and Integration Acceptance Process Flow Chart



*This flow chart applies to ITS equipment only; see Section 19.3 ETC System Coordination for information regarding ETC equipment requirements.

**Before notifying the Project Engineer and CDOT ITS that devices are ready for the LFOT to be witnessed, the Contractor shall self-perform the testing and verify everything is working.

Attachment A: Deliverables Checklist

Fiber Optic Cable Testing		
☐	Final OTDR test results	Date: _____
☐	Method Statement	Date: _____
☐	OTDR Trace Documentation (Prior to Installation)	Date: _____
☐	Continuity OTDR Trace (CWDM Optical Network)	Date: _____
☐	OTDR Trace (DWDM Optical Network)	Date: _____
☐	CWDM-OTDR Trace (CWDM Optical Network)	Date: _____
☐	Spectrum Analyzer Test Results (CWDM Optical Network)	Date: _____
☐	OTDR Traces and Power Meter Results (“Dark” Fiber Strands)	Date: _____
☐	Fiber Optic Cable As-Built Documentation Forms	Date: _____
Cabinets		
☐	Cabinet Testing Forms	Date: _____
Dynamic Message Signage (DMS) (VMS & VTMS Signs)		
☐	Device Information Sheet	Date: _____
☐	ITS As-Built Documentation Forms	Date: _____
☐	Device Commissioning Sheets from Manufacturer	Date: _____
☐	DMS Testing Forms	Date: _____
Closed Circuit Television (CCTV) Camera and Lowering Device		
☐	Device Information Sheet	Date: _____
☐	ITS As-Built Documentation Forms	Date: _____
☐	CCTV Testing Forms	Date: _____
Ramp Meter System (RMS)		
☐	Device Information Sheet	Date: _____
☐	ITS As-Built Documentation Forms	Date: _____
☐	RMS Testing Forms	Date: _____
Travel Time Indicator (TTI)		
☐	Device Information Sheet	Date: _____
☐	ITS As-Built Documentation Forms	Date: _____
☐	TTI Testing Forms	Date: _____
Microwave Vehicle Radar Detector (MVRD)		
☐	Device Information Sheet	Date: _____

☐	ITS As-Built Documentation Forms	Date: _____
☐	MVRD Testing Forms	Date: _____
☐	MVRD Detector Accuracy Verification Test: Volume Forms	Date: _____
☐	MVRD Detector Accuracy Verification Test: Speed Forms	Date: _____
☐	MVRD Detector Accuracy Verification Test: Occupancy Forms	Date: _____
DTD Automatic Traffic Recorders (ATR)		
☐	Device Information Sheet	Date: _____
☐	ITS As-Built Documentation Forms	Date: _____
☐	DTD ATR Testing Forms	Date: _____
Road Weather Information Systems (RWIS)		
☐	Device Information Sheet	Date: _____
☐	ITS As-Built Documentation Forms	Date: _____
☐	RWIS Testing Forms	Date: _____
Site Grounding		
☐	Ground Grid Measurement Results	Date: _____
☐	Copy of Earth Ground Resistance Tester's NIST Certification	Date: _____
☐	Grounding Testing Forms	Date: _____
30-Day Burn-In		
☐	Daily Equipment Failure Reports (EFRs)	Date: _____
☐	Documentation indicating successful passing of each test submitted to CDOT	Date: _____

Attachment B: Forms

Cabinet Testing Form

General Information

Date of Testing Notification to CDOT: _____ Date of Test: _____

Commission Date: _____ Manufacturer: _____

Model #: _____ Serial #: _____

Mile Marker: _____ Nearest Interchange: _____

Direction: _____ Project Stationing: _____

Username (If Required): _____ Password (If Required): _____

Method of Communication: _____

Visual Inspection			
Requirement	**Pass**	**Fail**	**Notes**
Verify the approved cabinet type is actually installed.	☐	☐	
Verify that the cabinet location is correct.	☐	☐	
Verify that the mounting bracket is fully intact, unbent, and contains the proper amount of securely tightened bolts (when pole mounted).	☐	☐	
Verify that conduit type(s) and cabinet entries are properly sealed with watertight bushings that don't leave sharp edges that can damage cable outer jackets (when pole mounted).	☐	☐	
Verify cabinet foundation type and size.	☐	☐	
Verify cabinet foundation height above surrounding finished grade.	☐	☐	
Verify that gap between cabinet and foundation has been sealed with a CDOT-approved silicone caulk.	☐	☐	
Verify that the proper number of anchor bolts are used with washers and nuts securely fastened.	☐	☐	
Verify that cabinet door hardware is functional; verify locking system is operational and conforms to CDOT-approved cabinet key type.	☐	☐	
Verify that cabinet door hinge area is not cracked.	☐	☐	
Verify that cabinet door seals are fully intact and functional.	☐	☐	
Verify that the document holder mounted on the inside of the cabinet door contains the required documents.	☐	☐	
Verify proper cable management.	☐	☐	
Verify the cabinet is correctly oriented on the foundation.	☐	☐	

Cabinet Testing Form (continued)

Cabinet Interior			
Requirement	**Pass**	**Fail**	**Notes**
Verify that equipment installed within the cabinet has not been damaged.	☐	☐	
Verify that all equipment inside the cabinet is properly secured (no loose or missing screws, etc.).	☐	☐	
Verify that all required equipment is properly installed with its associated power and communication cabling terminated safely and securely at each end.	☐	☐	
Verify that power and communication cables are not pinched when cabinet door closes.	☐	☐	
Verify that power and communication cables are not nicked or damaged and are properly labeled.	☐	☐	
Verify that conduit entries with cabling are properly sealed to prevent rodent and water infiltration; unused spare conduits must also be plugged with mechanical, water tight plugs.	☐	☐	

Thermal Management			
Requirement	**Pass**	**Fail**	**Notes**
Verify installation of cabinet fan and accompanying thermostat.	☐	☐	
Verify CFM rating of cabinet fan.	☐	☐	
Verify installation of a new cabinet filter at air intake.	☐	☐	
Verify temperature setting of thermostat and test to ensure both fan and thermostat are functional.	☐	☐	

Lighting			
Requirement	**Pass**	**Fail**	**Notes**
Verify installation of cabinet lighting.	☐	☐	
Verify light source for cabinet lighting is energy efficient.	☐	☐	
Verify that light source if functioning properly with door switch activation/deactivation.	☐	☐	

Cabinet Testing Form (continued)

Electrical			
Requirement	**Pass**	**Fail**	**Notes**
Verify that the power distribution panel is functional and is protected by approved overcurrent breakers.	☐	☐	
Verify that breakers are properly labeled.	☐	☐	
Verify that an approved main surge protector is installed.	☐	☐	
Verify conductor sizes and types used.	☐	☐	
Verify that there are no exposed 120 VAC terminals inside cabinet.	☐	☐	
Verify voltage in all electrical outlets within the cabinet are within +/- 10% of 120 VAC using a receptacle tester and/or digital multimeter.	☐	☐	
Verify GFCI outlet functionality by using the “Test” and “Reset” buttons.	☐	☐	
Verify voltages of all devices in the cabinet powered by external power supplies.	☐	☐	
Verify proper installation of cabinet UPS and any external batteries.	☐	☐	
Verify that cabinet UPS is plugged into a non-GFCI outlet.	☐	☐	
Verify that cabinet UPS has a network management card (if not integral to unit) with Ethernet interface.	☐	☐	
Verify that cabinet UPS works properly when power is turned off at feed point.	☐	☐	
Verify installation of equipment ground and all devices are tied to equipment ground using a grounding conductor or strap.	☐	☐	

Network			
Requirement	**Pass**	**Fail**	**Notes**
Verify that network-enabled devices in the cabinet have a label showing their IP address and subnet mask and are plugged into the Ethernet switch.	☐	☐	
Verify through the Ethernet switch that all network-enabled devices within (or connected to) the cabinet can be pinged with a laptop using PuTTY and the IP address of each device.	☐	☐	
Verify through the Ethernet switch that the designated CDOT gateway can be pinged with a laptop using PuTTY.	☐	☐	

Dynamic Message Sign Testing Form

General Information

Date of Testing Notification to CDOT: _____ Date of Test: _____

Commission Date: _____ Manufacturer: _____

Model #: _____ Serial #: _____

Mile Marker: _____ Nearest Interchange: _____

Direction: _____ Project Stationing: _____

Username (If Required): _____ Password (If Required): _____

Method of Communication: _____ IP Address: _____

Subnet Mask: _____ Controller Serial 3: _____

Pre-Installation Requirements			
Requirement	**Pass**	**Fail**	**Notes**
Inspect exterior and interior of sign for damage.	☐	☐	
Visually inspect power terminations within sign at main lugs and power supplies. Verify that connections are tight, clean, and landed in the correct polarity.	☐	☐	
Using a safe procedure, verify voltage from the panel board main breaker input lugs to neutral and record values for L1 to Neutral.	☐	☐	
Using a safe procedure, verify voltage from the panel board main breaker input lugs to neutral and record values for L2 to Neutral.	☐	☐	
Using a safe procedure, verify voltage from the panel board main breaker input lugs to neutral and record values for Neutral to Ground.	☐	☐	
Using a safe procedure, verify DC voltage on the breaker input in the sign display; value should be 24 VDC +/- 10%.	☐	☐	
Turn on sign controller power switch and verify that the power indicator LED is illuminated.	☐	☐	
Display the “All on 100% Burn” test pattern; check that all fans turn on. Once test is complete, set test pattern to “None”.	☐	☐	

Push the vent fan override button in the service control panel, if equipped, for the ventilation fans and verify that they turn on. Release it and verify that they turn off.	☐	☐	

General Requirements			
Requirement	**Pass**	**Fail**	**Notes**
Verify that Manufacturer's Commissioning has been completed.	☐	☐	
Verify that VMS installation satisfies the minimum vertical clearance from the highest point on roadway to lowest point of VMS (or its support structure).	☐	☐	

Electrical			
Requirement	**Pass**	**Fail**	**Notes**
Verify that all power conductors are of the size and type required and properly terminated.	☐	☐	
Verify voltage at cabinet is within +/- 10% of 120 VAC or 240 VAC.	☐	☐	
Verify voltage in sign load center is within +/- 10% of 120 VAC or 240 VAC.	☐	☐	
Verify sign and cabinet are properly grounded.	☐	☐	
Verify that after power cycling all equipment turns back on properly.	☐	☐	

Dynamic Message Sign Testing Form (continued)

Operations Test			
Requirement	**Pass**	**Fail**	**Notes**
Verify that controller correctly identifies the address of the controller, its ID, current time, and date.	☐	☐	
Verify that controller can be connected to laptop.	☐	☐	
Verify that a new message can be created, stored in memory, and recalled for display.	☐	☐	
Verify proper display of test messages and graphics in controller memory.	☐	☐	
Verify that sign can be blanked out.	☐	☐	
Verify proper installation and aiming of display modules.	☐	☐	
Verify that display modules are properly wired by displaying a text message that identifies the module's correct row and column position.	☐	☐	
Verify operation of every pixel, including uniform brightness at all brightness levels and proper electrical current consumption.	☐	☐	
Verify that brightness can be manually adjusted from controller.	☐	☐	
Verify that brightness can be set to "Auto" in controller and test operation of photo sensor(s).	☐	☐	
Verify door switch alarm.	☐	☐	
Verify correct wiring of alarms and sensors to the controller's input.	☐	☐	
Verify that all diagnostic routines can be successfully performed.	☐	☐	
Verify operation of sign monitoring through the controller.	☐	☐	

CCTV Camera Testing Form

General Information

Date of Testing Notification to CDOT: _____ Date of Test: _____

Commission Date: _____ Manufacturer: _____

Model #: _____ Serial #: _____

Mile Marker: _____ Nearest Interchange: _____

Direction: _____ Project Stationing: _____

Username (If Required): _____ Password (If Required): _____

Method of Communication: _____ IP Address: _____

Camera Lowering System			
Requirement	**Pass**	**Fail**	**Notes**
Verify the camera lowering system was properly installed by lowering and raising the CCTV to the ground three full cycles.	☐	☐	
Verify that CCTV is stable and locked at the top of the CLS.	☐	☐	
Verify that network cable has proper strain relief within pole and is not being damaged by movement of pulleys and support cable.	☐	☐	

CCTV			
Requirement	**Pass**	**Fail**	**Notes**
Verify quality of video and bandwidth setting.	☐	☐	
Verify streaming video in both JPEG and H264 formats.	☐	☐	
Verify pan, tilt, and zoom functionality.	☐	☐	
Verify manual and auto focus capability.	☐	☐	
Verify iris control.	☐	☐	

CCTV Camera Testing Form (continued)

Installation			
Requirement	**Pass**	**Fail**	**Notes**
Verify location of CCTV installation.	☐	☐	
Verify height of pole.	☐	☐	
Verify that CDOT-approved CCTV is installed.	☐	☐	
Verify voltage to PoE injector.	☐	☐	
Verify proper grounding of PoE injector power and network cable attachment.	☐	☐	
Verify shielding requirements of network cable and cable type is appropriate for outdoor installation.	☐	☐	

Ramp Metering System Testing Form

General Information

Date of Testing Notification to CDOT: _____ Date of Test: _____

Commission Date: _____ Manufacturer: _____

Model #: _____ Serial #: _____

Mile Marker: _____ Nearest Interchange: _____

Direction: _____ Project Stationing: _____

Username (If Required): _____ Password (If Required): _____

Method of Communication: _____

Ramp Metering System Testing Form (continued)

Installation			
Requirement	**Pass**	**Fail**	**Notes**
Verify that all demand detection zones have been installed.	☐	☐	
Verify that all passage detection zones have been installed.	☐	☐	
Verify that all queue detection zones have been installed.	☐	☐	
Check for indication of broken, cut, or exposed loop or lead-in wires.	☐	☐	
Check for exposed wire or missing sealant in loop slots.	☐	☐	
Verify that all lead-in wires have been properly twisted to avoid crosstalk and properly labeled.	☐	☐	
Verify loop lead in cables are properly identified and labeled in the cabinet and pull box specials.	☐	☐	
Verify that each loop is connected to the correct terminals on the input file.	☐	☐	
Verify the sensitivity on each loop amplifier channel (default value shall be 2).	☐	☐	
Verify that all unused channels of loop amplifiers are disabled.	☐	☐	
Verify that loop amplifiers are configured for 6'x6' loops and set on presence detection rather than pulse.	☐	☐	
Verify that all detection zones properly register the appropriate calls.	☐	☐	
Verify that the right side signal assembly is properly installed and signal heads operate correctly.	☐	☐	
Verify that the left side signal assembly is properly installed and signal heads operate correctly.	☐	☐	
Verify that the mast arm signal assembly is properly installed and signal heads operate correctly.	☐	☐	
Verify that the right side advance flashing beacon assembly is properly installed and operational.	☐	☐	
Verify that the left side advance flashing beacon assembly is properly installed and operational.	☐	☐	
Verify that the tripping of 208 watchdog timer card causes the signal heads and advance flashing beacons to go into yellow flash.	☐	☐	
Verify all equipment is properly grounded.	☐	☐	

Ramp Metering System Testing Form (continued)

Ramp Meter Loops Input File					
Location:					
Function	**Input File Slot**	**4 Channel**	**2 Channel**	**Field Connections**	**Verified**
HOV Detector	I-2U	Channel 3		I-2D,E	☐
Queue Detector 1	I-2L	Channel 4		I-2J,K	☐
Queue Detector 2	I-3U	Channel 1		I-3D,E	☐
Queue Detector 3	I-3L	Channel 2		I-3J,K	☐
Primary Upstream Detector 1	I-8U	Channel 1		I-8D,E	☐
Secondary Upstream Detector 1	I-8L	Channel 2		I-8J,K	☐
Primary Upstream Detector 2	I-7U	Channel 3		I-7D,E	☐
Secondary Upstream Detector 2	I-7L	Channel 4		I-7J,K	☐
Primary Upstream Detector 3	I-6U	Channel 1		I-6D,E	☐
Secondary Upstream Detector 3	I-6L	Channel 2		I-6J,K	☐
Primary Upstream Detector 4	I-5U	Channel 3		I-5D,E	☐
Secondary Upstream Detector 4	I-5L	Channel 4		I-5J,K	☐
Primary Upstream Detector 5	I-4U		Channel 1	I-4D,E	☐
Secondary Upstream Detector 5	I-4L		Channel 2	I-4J,K	☐
Primary Upstream Detector 6	I-9U	Channel 3		I-9D,E	☐
Secondary Upstream Detector 6	I-9L	Channel 4		I-9J,K	☐
Primary Upstream Detector 7	I-10U	Channel 1		I-10D,E	☐
Secondary Upstream Detector 7	I-10L	Channel 2		I-10J,K	☐
Primary Upstream Detector 8	I-11U		Channel 1	I-11D,E	☐
Secondary Upstream Detector 8	I-11L		Channel 2	I-11J,K	☐
Demand Detectors 1	I-12U	Channel 3		I-12D,E	☐
Passage Detector 1	I-12L	Channel 4		I-12J,K	☐
Demand Detectors 2	I-13U	Channel 1		I-13D,E	☐
Passage Detector 2	I-13L	Channel 2		I-13J,K	☐

Ramp Metering System Testing Form (continued)

Ramp Meter Loops Output File			
Location:			
Function	**Input File Slot**	**Field**	**Verified**
Ramp on Flasher	LS1 Red	PO 7	☐
Signal Red	LS2 Red	PO 4	☐
Signal Yellow	LS2 Yel	T210	☐
Signal Green	LS2 Grn	PO 6	☐

MVRD Testing Form

General Information

Date of Testing Notification to CDOT: _____ Date of Test: _____

Commission Date: _____ Manufacturer: _____

Model #: _____ Serial #: _____

Mile Marker: _____ Nearest Interchange: _____

Direction: _____ Project Stationing: _____

Username (If Required): _____ Password (If Required): _____

Method of Communication: _____ IP Address: _____

Tested by: _____ CDOT Witness: _____

General			
Requirement	**Pass**	**Fail**	**Notes**
Verify that MVRD is installed at the correct location.	☐	☐	
Verify that the top of the MVRD cabinet is about 5’ to 7’ above finished grade.	☐	☐	
Verify that MVRD cabinet is oriented such that maintenance personnel will have a direct line-of-sight with oncoming traffic.	☐	☐	
Complete MVRD Detector Accuracy Verification Test for Volume.	☐	☐	
Complete MVRD Detector Accuracy Verification Test for Speed.	☐	☐	
Complete MVRD Detector Accuracy Verification Test for Occupancy.	☐	☐	

MVRD Testing Form (continued)

Electrical			
Requirement	**Pass**	**Fail**	**Notes**
Verify that all power connectors include a quick disconnect.	☐	☐	
Verify that MVRD AC circuit breaker is properly sized, installed on DIN rail, and connected to AC line.	☐	☐	
Verify that MVRD AC surge protector is properly installed on DIN rail and connected to circuit breaker and AC neutral.	☐	☐	
Verify that MVRD power supply is sized appropriately for the required voltage and number of MVRDs it will be powering.	☐	☐	
Verify that MVRD power supply is connected to AC surge protector on input side and to each lightning surge protector on output side.	☐	☐	
Verify DIN rail is properly grounded.	☐	☐	
Verify that the manufacturer's recommended power/communication cable is being used and is of adequate length.	☐	☐	
Verify power supply has AC to DC converter mounted to DIN rail and measure output voltage of power supply.	☐	☐	

Alignment			
Requirement	**Pass**	**Fail**	**Notes**
Verify that the lateral mounting meets the minimum and maximum allowable setbacks per the manufacturer's recommendations.	☐	☐	
Verify that MVRD mounting is in compliance with manufacturer's recommended installation method	☐	☐	
Verify the height of MVRD above finished grade and if it conforms with manufacturer's recommendations.	☐	☐	
Verify that MVRD is mounted with its cable connector down and tilted so that it is aimed in accordance with manufacturer's requirements.	☐	☐	
Verify that MVRD's view of roadway is not obstructed.	☐	☐	
Verify that contact closure card is properly installed in card rack and receiving actuations.	☐	☐	
Verify address of the contact closure card.	☐	☐	
Verify that patch cords are securely terminated between each contact closure card and lightning surge protector.	☐	☐	
Verify that sensor cable is properly terminated to each lightning surge protector.	☐	☐	

MVRD Detector Accuracy Verification Test: Volume

Site: _____

Date: _____ Time: _____

Objective

To verify and demonstrate the functionality and accuracy of volume for the detector locations.

Prerequisites

Detector and cabinet installation must be complete. Lane must be open to traffic. ATMS inspector must be present during testing.

Test Equipment

A stop watch and traffic count board.

Success Criteria

Volume obtained from each detector for each lane of traffic will be within +/- 10 percent of each sample size. Sample size will be ten minutes, or 50 vehicles, whichever comes first. Traffic will be running at typical free-flowing speed and condition.

Test Instructions

1. Record the observed actual hand count volume and detector counts for ten minutes, or 50 vehicles, whichever comes first.
2. Record the volume of vehicles detected by the sensor over the test period.
3. Subtract hand count volume from detector count volume and then divide by the hand count volume. Multiply by 100 to get the percent accuracy.
4. Indicate pass if result is +/- 10 percent.
5. Adjust sensitivity and repeat if percent accuracy is out of range.

MVRD Detector Accuracy Verification Test: Volume (continued)

Volume Test Results					
Lane #					
Test Duration (min:sec)					
Observed Hand Count Volume					
Detector Count Volume (from Laptop)					
% Accuracy = (100 x (detector count – hand count)/(hand count))					
Pass or Fail (Pass if accuracy is < +/- 10%					
Sensitivity Setting					
Test Completed by (Installer's Tester)					
Date					
Test Inspected by (ATMS Inspector)					

MVRD Detector Accuracy Verification Test: Speed

Site: _____

Date: _____ Time: _____

Objective

To verify and demonstrate the functionality and accuracy of speed for detector locations. Note that this test is applicable to Wavetronix Smart Sensor HD units that compute rolling average speed. Also note that this speed testing is not required for freeway on/off ramps, only for mainline detection.

Prerequisites

Detector and cabinet installation must be complete. Lane must be open to traffic. CDOT Inspector must be present during testing.

Test Equipment

A calibrated radar gun, a stop watch, 2-way radios, and a laptop.

Procedure

1. Record distance L from radar gun to detector site.
2. Record offset O from center of each lane to radar gun site.
3. Compute the resultant angle theta (= inverse tangent (O / L)), which is the angle between radar gun beam and vehicle travel direction.
4. Compute cosine theta, which is the speed correction factor for the measurement angle.
5. Ensure that Detector unit is functioning, and that rolling average speed is being recorded.
6. Set the interval on the detector unit to 3 minutes.
7. Record the individual speeds of 16 consecutive vehicles using radar gun. If measuring consecutive vehicles is not possible, measure speeds for as many vehicles in the lane as possible, for 16 vehicles or 3 minute time period, whichever comes first.
8. Simultaneously to recording the 16th vehicle, or completing the 3 minute time period, immediately record the current Detector Mean Speed as indicated at that moment by the Detector unit.
9. Compute the mean (Average) speed of the 16 vehicles, based on radar gun readings.
10. Compute the Modified Radar Gun Mean Speed (= radar gun mean speed / cosine theta), if needed, if radar gun is not shooting head-on at vehicles.
11. Compare the Modified Radar Gun Mean Speed to the Detector Mean Speed. Pass if difference < 5 mph. If test does not pass, adjust the sensitivity of the sensor and retest.
12. Repeat for each lane.

MVRD Detector Accuracy Verification Test: Speed (continued)

Set-up Data

Radar Unit Type, Model, and Serial #: _____

Record Distance L from Radar Site to Detector Site: _____

Record Offset O from Radar Site to Center of Lane 1: _____

Compute Theta 1: _____ Compute Cosine Theta 1: _____

Record Offset from Radar Site to Center of Lane 2: _____

Compute Theta 1: _____ Compute Cosine Theta 1: _____

Record Offset from Radar Site to Center of Lane 3: _____

Compute Theta 1: _____ Compute Cosine Theta 1: _____

Record Offset from Radar Site to Center of Lane 4: _____

Compute Theta 1: _____ Compute Cosine Theta 1: _____

Record Offset from Radar Site to Center of Lane 5: _____

MVRD Detector Accuracy Verification Test: Speed (continued)

Speed Test Results					
Lane #					
Vehicle #	Speed form Radar Gun Display (mph)	Speed from Radar Gun Display (mph)	Speed form Radar Gun Display (mph)	Speed form Radar Gun Display (mph)	Speed form Radar Gun Display (mph)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
Radar Gun Mean Speed (mph)					
Cosine Theta					
Modified Radar Gun Mean Speed (mph)					
Detector Mean Speed (mph)					
Pass or Fail (Pass if Modified Radar Gun and Detector Mean Speeds are within +/- 5 mph)					
Sensitivity Setting					
Does Controller Properly Record Occupancy?					
Test Completed by (Installer's Tester)					
Date					
Test Inspected By (ATMS Inspector)					

MVRD Detector Accuracy Verification Test: Occupancy

Site: _____

Date: _____ Time: _____

Objective

To verify and demonstrate the functionality and accuracy of occupancy for the detector locations.

Prerequisites

Detector and cabinet installation must be complete. Lane must be open to traffic. ATMS Inspector must be present during testing.

Test Equipment

A stop watch, a traffic count board, and a laptop.

Success Criteria

Occupancy obtained from each detector for each lane of traffic will be within +/- 5 percent of each sample size. Sample size will be three minutes. Traffic will be running at typical free-flowing speed and condition.

Test Instructions

1. Record the observed actual hand count occupancy and sensor counts for three (3) minutes.
2. Record the occupancy of vehicles detected by the sensor over the test period.
3. Subtract hand count volume from detector count volume and then divide by the hand count volume. Multiply by 100 to get the percent accuracy.
4. Indicate pass if result is +/- 5%.
5. Adjust sensitivity and repeat if % accuracy is out of range.

Occupancy Measurements	
# of Axles	**Vehicle Length (Approximate)**
2	20 feet
3	30 – 40 feet
>3	> 40 feet

Use the chart above to determine the number of axles by vehicle length. Choose a populated lane and monitor the occupancy of the lane for three (3) minutes. Use the chart on the next page to complete the test.

MVRD Detector Accuracy Verification Test: Occupancy (continued)

Occupancy Test Results										
Lane #	Time Duration (min:sec)	Observed Occupancy Counts			Occupancy (from Laptop)			% Accuracy	Pass/Fail	Sensitivity Setting
		2 Axle	3 Axle	>3 Axle	2 Axle	3 Axle	>3 Axle	= 100 x (laptop – observed) / (observed)	Pass if < +/- 5%	

TTI Testing Form

General Information

Date of Testing Notification to CDOT: _____ Date of Test: _____

Commission Date: _____ Manufacturer: _____

Model #: _____ Serial #: _____

Mile Marker: _____ Nearest Interchange: _____

Direction: _____ Project Stationing: _____

Username (If Required): _____ Password (If Required): _____

Method of Communication: _____ IP Address: _____

Tested By: _____ CDOT Witness: _____

Installation			
Requirement	**Pass**	**Fail**	**Notes**
Verify TTI installation location.	☐	☐	
Verify that all power connections include a quick disconnect.	☐	☐	
Verify installation of grounding and surge protection.	☐	☐	
Verify power supply is properly sized and installed on DIN rail.	☐	☐	
Verify output of power supply.	☐	☐	

Cabling			
Requirement	**Pass**	**Fail**	**Notes**
Verify type of conduit used to run cables and proper termination techniques on each end.	☐	☐	
Verify that conduits enter cabinets through bottom (preferred) or side (alternative)	☐	☐	
Verify that all cable entrances are sealed and waterproof.	☐	☐	
Verify that all drilled holes for installing cabling in mounting structures must be free of burrs and sharp edges.	☐	☐	
Verify that all signal cables are continuous and unspliced.	☐	☐	
Verify that each cable utilizes a unique color tape on each end that is resistant to fading due to UV exposure.	☐	☐	

TTI Testing Form

Antenna			
Requirement	**Pass**	**Fail**	**Notes**
Verify that antenna signal cables are terminated to the correct ports for EB and WB directions as well as GP and Express lanes.	☐	☐	
Verify that reader is a CDOT-approved model and properly installed.	☐	☐	
Verify that the coaxial cable connector on the cable is appropriate for the antenna without the use of adapters.	☐	☐	
Verify antenna mounting height and orientation for intersecting with oncoming traffic at a 45-degree angle.	☐	☐	
Verify that antenna is aimed at the center of the appropriate lane per CDOT requirements.	☐	☐	
Verify that coaxial cable is sized appropriately for the run length and corresponding signal attenuation.	☐	☐	
Test coaxial cable with RF tester and record results. Attenuation loss shall conform to CDOT's dB requirements.	☐	☐	
Verify that installation is reading the RFID protocols of different ExpressToll tags.	☐	☐	
Verify that Python software is operational.	☐	☐	

Serial Configuration			
Requirement	**Pass**	**Fail**	**Notes**
Confirm serial configuration required by the manufacturer is being utilized: bitrate, data bits, parity, stop bits, and flow control.	☐	☐	

Accuracy Testing			
Requirement	**Pass**	**Fail**	**Notes**
Is the number of tag reads from Express lane(s) picked up by GP antennas > 0? If yes, re-aim antennas and test again.	☐	☐	
Is the number of tag reads from GP lanes picked up by Express lane antennas > 0? If yes, re-aim antennas and test again.	☐	☐	
Is the number of tag reads from Express lane within +/- 10% of the actual number of that pass through?	☐	☐	
Is the number of tag reads from GP lane within +/- 10% of the actual number of that pass through?	☐	☐	

DTD ATR Testing Form

General Information

Date of Testing Notification to CDOT: _____ Date of Test: _____

Commission Date: _____ Manufacturer: _____

Model #: _____ Serial #: _____

Mile Marker: _____ Nearest Interchange: _____

Direction: _____ Project Stationing: _____

Username (If Required): _____ Password (If Required): _____

Method of Communication: _____

Installation			
Requirement	**Pass**	**Fail**	**Notes**
Verify that all detection zones have been installed.	☐	☐	
Verify that loop sawcuts are finished and level with roadway without excess epoxy.	☐	☐	
Verify all equipment is properly grounded.	☐	☐	

Lanes			
Requirement	**Pass**	**Fail**	**Notes**
Verify that the detection works properly for each lane that loops are installed.	☐	☐	

DTD ATR Testing Form (continued)

Piezo Loops			
Requirement	**Pass**	**Fail**	**Notes**
Using a LCR meter, verify that the capacitance is within the tolerances specified by the manufacturer.	☐	☐	
Using a LCR meter, verify that the dissipation factor is within the tolerances specified by the manufacturer.	☐	☐	
Verify that installed piezo sensors are class II (used to collect axle classification data).	☐	☐	
Verify that sensor misses per lane shall not exceed the requirements of DTD during the test period.	☐	☐	
Verify that loop continuity must not exceed 1 ohm.	☐	☐	
Verify that voltage for a front axle of a car is not less than 80 mV.	☐	☐	

Data Retrieval			
Requirement	**Pass**	**Fail**	**Notes**
Verify that real-time vehicle viewing per selected lane can be performed.	☐	☐	
Verify that system data retrieval does not impact data collection operation.	☐	☐	
Verify that device supports collection of data for opposing lanes of traffic.	☐	☐	

Accuracy			
Requirement	**Pass**	**Fail**	**Notes**
Verify that piezos and loops were tested under actual traffic conditions.	☐	☐	
Verify that one week of data was collected.	☐	☐	
Verify that the volume count is within +/- 10 percent accuracy for the site compared to historical data.	☐	☐	
Verify that the vehicle classification type is within +/- 10 percent accuracy for the site compared to historical data.	☐	☐	
Verify that sensor misses do not exceed 1 percent in each lane during the test period.	☐	☐	

RWIS Testing Form

General Information

Date of Testing Notification to CDOT: _____ Date of Test: _____

Commission Date: _____ Manufacturer: _____

Model #: _____ Serial #: _____

Mile Marker: _____ Nearest Interchange: _____

Direction: _____ Project Stationing: _____

Username (If Required): _____ Password (If Required): _____

Method of Communication: _____ IP Address: _____

RWIS Testing Form (continued)

Installation			
Requirement	**Pass**	**Fail**	**Notes**
Verify installation location.	☐	☐	
Verify that heavy duty fold over tower was installed per CDOT requirements.	☐	☐	
Verify that base assembly was installed per CDOT requirements.	☐	☐	
Verify that concrete footing was installed per CDOT requirements.	☐	☐	
Verify that concrete pad was installed per CDOT requirements.	☐	☐	
Verify that system is properly grounded.	☐	☐	
Verify that chain link fence is 5’ to 7’ tall and installed within 6’-2” of the edge of the concrete along the perimeter.	☐	☐	
Verify that a 3’-6” or 4’-0” gate is provided in the chain link fence with locking hasps and end caps centered opposite the hinged side of the tower to allow access to fold down tower.	☐	☐	
Verify that tower is mounted in a direction that will not impede traffic when folded down.	☐	☐	
Verify that air temperature/relative humidity sensor is mounted on the tower 6’ above finished grade.	☐	☐	
Verify that the wind sensor is mounted on the tower at 30’ above finished grade.	☐	☐	
Verify that the PTZ camera is mounted on the tower at 27’ above finished grade.	☐	☐	
Verify that the non-intrusive road surface state sensor is mounted at an angle recommended by the manufacturer.	☐	☐	
Verify that data from temperature, humidity, windspeed, and road surface sensors are being collected and processed by processing unit.	☐	☐	

Grounding Testing Form

General Information

Date of Testing Notification to CDOT: _____ Date of Test: _____

Mile Marker: _____ Nearest Interchange: _____

Direction: _____ Project Stationing: _____

Username (If Required): _____ Password (If Required): _____

Test Meter Manufacturer: _____ Test Meter Model No.: _____

Test Meter Serial No.: _____ Test Meter Calibration Date: _____

Test Conducted By: _____

Test Conditions

Soil Condition (Check One): ☐ Dry ☐ Moist

Temperature: _____ °F

Soil Type (Check One): ☐ Clay ☐ Granite ☐ Limestone ☐ Loam ☐ Shale ☐ Sand and Gravel ☐ Slate ☐ Sandstone ☐ Other _____

Number of Rods Used (Circle One): 1 2

Final Rod Depth: _____ feet

Effective Grounding Electrode Resistance: _____ Ω

Grounding Testing Form (continued)

General Requirements			
Requirement	**Pass**	**Fail**	**Notes**
Verify that ground rods are copper-clad steel not less than 0.625" diameter and a minimum of 8' length.	☐	☐	
Verify that CDOT approved other ground rod type if copper-clad steel was not used.	☐	☐	
Verify that grounding electrode conductor is not less than #6 AWG.	☐	☐	
Verify that braided ground straps consist of non-insulated tinned copper flat braid wire not less than 0.5" width and 0.07" thick (for bonding between a cabinet frame and busbar only).	☐	☐	
Verify that insulated grounding electrode conductors are Type THWN with green jacket color.	☐	☐	
Verify that grounding electrode conductor was installed in a continuous run without splices or joints.	☐	☐	
Verify that connectors are exothermic weld for below grade connections and areas exposed to moisture.	☐	☐	
Verify that connectors are UL listed compression connectors for above grade installations and where safety dictates.	☐	☐	
Verify that ground bus is copper bar stock with stainless steel stand-off brackets and mounting hardware.	☐	☐	
Measure resistance of the first installed grounding electrode and test with earth ground resistance tester (3-point fall of potential method). If results exceed 10 ohm, a second grounding electrode needs to be installed.	☐	☐	
Verify that second grounding electrode is at least one electrode length away from the first grounding electrode and connected via bonding jumper.	☐	☐	
Measure grounding electrode system resistance with earth ground resistance tester (3-point fall of potential method). CDOT will accept 25 ohm or less after two grounding electrodes have been installed.	☐	☐	
Verify that oxidation and antioxidant compound was used at connection points to ground bus.	☐	☐	
Verify that stainless steel hardware was used and torqued to a specific value based on hardware grade, material, and size.	☐	☐	
Verify that connections to ground bus utilize a flat washer and Bellville washer for each bolt.	☐	☐	
Verify that all exothermic welds have slag removed.	☐	☐	
Verify that testing is performed prior to connecting to utility ground.	☐	☐	

20.0 MODIFICATIONS TO STANDARD SPECIFICATIONS

20.1 Construction Requirements

This Section sets forth modifications to the CDOT *Standard Specification for Road and Bridge Construction* for design-build projects. The first section contains revisions to Division 100 of the Standard Specifications. The second section contains revisions to Divisions 200 through 700 of the Standard Specifications, as well as Standard Special Provisions applicable to the Project.

These Contract Provisions are a revised version of CDOT's *Standard Specifications for Road and Bridge Construction*, and contain requirements generally applicable to the Work to be performed by the Contractor. In certain cases, provisions in Section 100 of the *Standard Specifications for Road and Bridge Construction* have been superseded by other provisions of the Contract Documents. For ease of reference, this document uses the same Section numbers as the *Standard Specifications for Road and Bridge Construction*, and identifies provisions of the Contract Documents that have replaced or modified the standard clauses.

All references to "Engineer" that are incorporated into this RFP refer to the Contractor's Engineer, unless the context requires otherwise. Non-capitalized terms, such as "work" that are defined in Book 1, Exhibit A, shall have the meanings defined therein unless the context requires otherwise. References to "approve, approval or approved" shall mean "Approve, Approval or Approved" as defined in Book 1, Exhibit A, when the approval is by CDOT or a division of CDOT. If the interpretation(s) pursuant to this paragraph are not clear, CDOT shall decide, in its sole discretion, how these terms shall be interpreted.

When these specifications describe actions, Materials, means or methods that are required and that are qualified by phrases such as: "as directed by the Engineer", "when directed by the Engineer", "as determined by the Engineer", "with or without permission of the Engineer", "in the opinion of the Engineer", "unless authorized by the Engineer", "satisfactory to the Engineer", "as approved by the Engineer", or "unless another type is specified or is permitted with approval of the engineer", such phrases shall be disregarded. If it is not clear whether a phrase should be disregarded, CDOT will make that decision in its sole discretion.

When these specifications refer to " Department", "Resident Engineer", "Agricultural Engineer", "Bridge, Construction or Maintenance Engineer", "TMC system inspector", "Concrete Engineer", "Project Engineer", "Materials Engineer", "Commissioner", "Structural Metals Engineer", "Department's Lighting Engineer", "Geotechnical Engineer" or any other specific CDOT special engineer, such reference shall mean the CDOT Project Manager, unless otherwise indicated in these modifications to the standard specifications.

When these specifications use the term engineer relating to the approval of any activities involving the use of explosives, such term shall mean the CDOT Project Manager.

When an approval or authorization of the Engineer or CDOT is required in these specifications for the use of alternative or substituted processes or components, the Engineer shall mean

CDOT. If it is not clear whether a phrase involves the use of alternative or substituted processes, CDOT will make that determination in its sole discretion.

If these specifications refer to an approval of any correction or repair that deviates from the Contract requirements, the approval must be by CDOT. If it is not clear whether a specification involves a correction or repair that deviates from the Contract requirements, CDOT will make that determination in its sole discretion.

When these specifications provide that reports, records or other documents shall be submitted to CDOT or to the Engineer, such reports shall be made available to CDOT and do not have to be submitted unless either they are otherwise listed in the deliverables in the Contract Documents, or are required shop drawings, warranties, parts lists, instruction sheets or manufacturer's drawings or specifications. Such documents shall be submitted to CDOT as required by the specifications.

When these specifications require actions, Materials, means or methods that are "either as indicated in the Plans or as designated by the Engineer," the Contractor shall disregard the phrase "or as designated by the Engineer."

When these specifications refer to the "Engineer" ordering work beyond the scope of work in the Contract, "Engineer" shall mean CDOT. Whenever in these specifications the Engineer may order work that results in additional costs to CDOT, the "Engineer" shall mean CDOT.

Any acceptances on behalf of CDOT or the State shall be performed by CDOT.

Any references to other standards, codes, or criteria, or to the latest version of other standards, codes, or criteria in Book 2 of the Contract Documents shall mean the latest version at the Proposal Due Date.

20.1.1 Modifications to Section 100 of the Standard Specifications for Road and Bridge Construction

101 - Definitions

Definitions of terms used herein are set forth in Exhibit A to Book 1 of the Contract Documents.

102 – Bidding Requirements and Conditions

102.01 - Prequalification of Bidders

Prequalification of Proposers was determined during the evaluation of the Statements of Qualifications.

102.02 - Contents of Proposal Forms

Provisions regarding the contents of Proposal Forms are set forth in the Instructions to Proposers.

102.03 - Interpretation of Quantities in Proposal Form

Not applicable.

102.04 - Interpretation of Plans and Specifications

Provisions regarding the interpretation of plans and specifications are set forth in the Instructions to Proposers.

102.05 - Examination of Plans, Specifications, Special Provisions, and Site or Work

Provisions regarding examination of plans, specifications, special provisions and site of work are set forth in the Instructions to Proposers and in Sections 1 and 2, Book 1 of the Contract Documents.

102.06 - Preparation of Proposal

Provisions regarding preparation of the Proposal are set forth in the Instructions to Proposers.

102.07 - Irregular Proposals

Provisions regarding irregular Proposals are set forth in the Instructions to Proposers.

102.08 - Combination or Conditional Proposals

Not applicable.

102.09 - Anti-Collusion Affidavit

Provisions regarding Anti-Collusion Affidavit are set forth in the Instructions to Proposers.

102.10 - Material Guaranty

Provisions regarding Material Guaranty are set forth in Section 21, Book 1 and the Quality Section of Book 2 of the Contract Documents.

103 – Award, and Execution of Contract

Provisions regarding award and execution of the Contract are set forth in the Instructions to Proposers and in Sections 7, Book 1 of the Contract Documents.

104 - Scope of Work

104.01 - Intent of Contract

Provisions regarding the intent of contract are set forth in Book 1 of the Contract Documents.

104.02 -Differing Site Conditions, Suspensions or Work, and Significant Changes in the Character of Work

Provisions regarding differing site conditions and changes in the character of Work are set forth in Sections 5 and 13, Book 1 of the Contract Documents. Provisions regarding limitations to contract price increases are set forth in Section13.5, Book 1 of the Contract Documents. Provisions regarding Suspensions of Work are set forth in Section 14, 15.15 Book 1 of the Contract Documents.

104.03 - Extra Work

Provisions regarding changes are set forth in Section 13, Book 1 of the Contract Documents.

104.04 - Maintaining Traffic

The provisions regarding maintenance of traffic are set forth in the Transportation Management Plan and Maintenance During Construction Sections, Book 2 of the Contract Documents. Provisions regarding maintenance responsibilities of Contractor during Suspensions of Work are set forth in Section 14, Book 1 of the Contract Documents.

104.05 - Rights In and Use of Materials Found on the Work

The provisions regarding rights in and use of Materials found on the Work are replaced with the following:

The Contractor shall not excavate or remove any Material from within the roadway, which is not within the grading limits, as indicated by the slope and grade lines, without written authorization from CDOT.

Unless otherwise provided, the material from structures designated for removal shall be the Contractor's property and may be used temporarily by the Contractor in the erection of the new structures.

104.06 - Final Cleaning Up

Provisions regarding final cleaning up before final acceptance are fully incorporated herein.

104.07 - Value Engineering Change Proposals by the Contractor

Provisions regarding value engineering change proposals by the Contractor are set forth in Section 12, Book 1 of the Contract Documents.

105 - Control of Work

105.01 - Authority of the Engineer

The provisions regarding Control of Work are set forth in Section 5, Book 1 of the Contract Documents. CDOT has the authority by written order to suspend the Work wholly or in part for the reasons delineated in Section 14, Book 1 of the Contract Documents.

105.02 - Plans, Shop Drawings, Working Drawings, other Submittals and Construction Drawings

Provisions regarding plans, shop drawings, working drawings and construction documents are set forth in the Quality Section, Book 2 of the Contract Documents.

105.03 - Conformity to the Contract

The provisions regarding conformity to the Contract are revised as follows:

1. No incentive payments will be made under this Contract.

2. For those items of Work where working tolerances are not specified, the Contractor shall perform the Work in a manner consistent with reasonable and customary manufacturing and construction practices.

3. When the Engineer or CDOT finds that the Materials furnished, the Work performed, or the finished product does not conform with the Contract Documents, but CDOT determines, in its sole discretion, that reasonably acceptable Work has been produced, CDOT will determine the extent the Work will be Accepted and remain in place. If accepted, the Contractor shall (a) document the basis for Acceptance based on CDOT's determination by Change Order which will provide for an appropriate reduction in the Contract price for such Work or Materials not otherwise provided for in this Subsection or (b) CDOT will notify the Contractor in writing that the agreed-upon unit price will be reduced in accordance with this Subsection when P is 25 or less, or (c) CDOT may notify the Contractor in writing if there should be no reduction in the Contract Price; or in lieu of a price reduction, CDOT may permit correction or replacement of the finished product, provided the correction or replacement does not adversely affect the Work.

4. For purposes of Nonconforming Work, the Contractor shall propose a unit price for determining the reduction in the Contract price, with supporting documentation. The unit price is subject to Approval of CDOT. The reduction in Contract price shall take place as provided in this Section 105.03, based upon the Approved unit price. The Change Order shall be prepared in accordance with this Section 105.03.

5. When the Engineer or CDOT finds the Materials furnished, Work performed, or the finished product are not in conformity with the Contract Documents, and CDOT determines, in his sole discretion, that it has resulted in an inferior or unsatisfactory product, the Work or Materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

6. Materials will be sampled and tested by the Contractor in accordance with the sampling and testing schedules and procedures contained in the Contract Documents. The quantity represented by five consecutive random samples will constitute a lot whenever production schedules and Material continuity permit. The Engineer may establish a lot consisting of the quantity represented by any number of consecutive random samples from one to seven inclusive when it is necessary to represent short production runs, significant Material changes, or other unusual characteristics of the Work. Tests that are determined to have sampling or testing errors will not be used.

7. Materials or Work will be evaluated for price reduction only when deviations from the requirements of the Contract Documents occur on any of the several individual tests for the lot. The several individual test values will be averaged and the percent of price reduction for the lot will be determined by applicable formula and table as shown in Section 105.03.

Price reduction for those elements, which are not included in the Table of Price Reduction Factors as shown in Section 105.03 will be proposed by the Contractor for Approval by CDOT.

The Contractor will not have the option of accepting a price reduction in lieu of producing Material that complies with the Contract Documents. Continued production of nonconforming Material will not be permitted. Material, which is obviously defective, may be isolated and rejected by CDOT without regard to sampling sequence or location within a lot.

105.05 Conformity to the Contract of Hot Mix Asphalt

The provisions regarding conformity to the Contract of Hot Mix Asphalt is revised as follows:

No incentive payments will be made under this Contract.

105.06 Conformity to the Contract of Portland Cement Concrete Pavement

The provisions regarding conformity to the Contract of Portland Cement Concrete Pavement is revised as follows:

No incentive payments will be made under this Contract.

105.07 Conformity to Roadway Smoothness Criteria of HMA

The provisions regarding conformity to Roadway Smoothness Criteria for HMA is revised as follows:

Pavement Smoothness Category of HMA shall be HRI Category II (see Book 2 Section 10 Table 10.3.2.6)

No incentive payments will be made under this Contract.

105.08 Conformity to Roadway Smoothness Criteria of Portland Cement Concrete Pavement

The provisions regarding conformity to Roadway Smoothness Criteria for Portland Cement Concrete Pavement is revised as follows:

Pavement Smoothness Category of PCCP shall be HRI Category II (See Book 2 Section 10 Table 10.3.2.6).

The Contractor, not the Department, shall be responsible for performance and evaluation of all smoothness testing including Initial Smoothness Acceptance Testing and Final Smoothness Acceptance Testing. Smoothness Acceptance Testing shall be performed under the Contractor's ICQC Team by a firm separate from the Smoothness Quality Control Testing firm. The Department may perform Smoothness Verification Testing at its sole discretion.

No incentive payments will be made under this Contract.

105.09 - Coordination of Plans, Specifications, Supplemental Specifications, and Special Provisions

Section 1.3, Book 1 of the Contract Documents sets forth the order of priority of the various Contract Documents.

105.10 - Cooperation by Contractor

Provisions regarding cooperation by the Contractor are set forth in Book 1, Section 2.2, of the Contract Documents.

105.11 - Cooperation with Utilities

Provisions regarding cooperation with utilities are fully incorporated herein, except that the reference to Extra Work is not applicable and the provisions for delays are set forth in Book 1, Section 6.2 and the Utility Section, Book 2 of the Contract Documents.

105.12 - Cooperation Between Contractors

Provisions regarding Cooperation between Contractors are set forth in Book 1, Section 23.0 and in Book 2, Section 16 - Transportation Management Plan of the Contract Documents.

105.15 - Duties of the Inspector

Provisions regarding inspection of the Work are set forth in Book 1, Sections 5 and 22 and Book 2, Section 3 - Quality Management of the Contract Documents.

105.16 - Inspection and Testing or Work

Provisions regarding inspection and testing of the Work are set forth in Book 1Sections 5 and 22, Book 2, Section 2 – Project Management and; Book 2, Section 3 – Quality Management of the Contract Documents.

105.17 - Removal of Unacceptable Work and Unauthorized Work

Book 1, Section 5.7 of the Contract Documents provides for removal of nonconforming Work.

105.18 - Load Restrictions

The provisions regarding load restrictions are incorporated herein except that the fourth and fifth paragraphs are replaced with the following:

If a scale ticket from an overweight vehicle is inadvertently accepted and the Material incorporated into the Project, CDOT will adjust the price for the overweight load as follows:

1. The Contract price will be reduced by an amount based upon the pay item quantity represented by the amount of Material in excess of the legal weight according to a unit price to be proposed by the Contractor, with supporting documentation, and Approved by CDOT.

105.19 - Maintenance During Construction

Provisions for maintenance during construction are set forth in Book 1, Section 10 and Book 2, Section 18 - Maintenance During Construction of the Contract Documents.

105.20 - Failure to Maintain Roadway or Structure

Provisions for failure to maintain the roadway or structure are set forth in Book 2, Section - Section 18 - Maintenance During Construction of the Contract Documents.

105.21 - Acceptance

Provisions regarding Segment Completion and Final Acceptance are set forth in Book 1, Section 20 of the Contract Documents.

105.22, 105.23, and 105.24 – Disputes and Claims for Contract Adjustments

Provisions regarding claims for Contract adjustments are set forth in Book 1, Section 13 and provisions regarding Dispute Resolution are set forth in Book 1, Section 19 of the Contract Documents.

106 - Control of Material

106.02 - Material Sources

Provisions regarding Material sources are set forth in the Quality Section, Book 2 of the Contract Documents. The provisions regarding hazardous Materials are set forth in Book 1, Sections 5.3, 13.11, 18.1, and 18.2 of the Contract Documents.

106.03 - Samples, Tests, and Cited Specifications

Provisions regarding quality control and quality assurance are set forth in the Quality Section, Book 2 of the Contract Documents.

Unless otherwise designated, when AASHTO, ASTM, or other specifications, standards, or policies are cited, the reference shall be to the latest edition as revised or updated by approved supplements or interim editions published and issued as of the Proposal Due Date unless otherwise indicated.

106.07 - Material Inspection at Plant

Provisions regarding Material inspection at the plant are set forth in the Quality Section, Book 2 of the Contract Documents.

106.08 - Storage of Materials

Provisions regarding storage of Materials are set forth in the Quality Section, Book 2 of the Contract Documents.

106.09 - Handling Materials

Provisions regarding the handling of Materials are set forth in the Quality Section, Book 2 of the Contract Documents.

106.11 – Buy America

Provisions regarding Buy America are incorporated.

106.12 - Certificates of Compliance

Provisions regarding Certificates of Compliance are incorporated.

106.13 - Certified Test Report

Provisions regarding Certified Test Reports are incorporated.

107 - Legal Relations and Responsibility to Public

107.02 - Permits, Licenses, and Taxes

Provisions regarding permits, licenses and taxes are set forth in Book 1, Section 2.2 of the Contract Documents.

107.04 - Restoration of Surfaces Opened by Permit

Provisions regarding restoration of surfaces opened by a permit to construct or reconstruct a utility service are set forth in Book 1, Section 6.2 and the Utility Section, Book 2 of the Contract Documents.

107.05 - Federal Aid Provisions

Provisions regarding Federal Aid Provisions are contained in the Federal Requirements exhibit to Book 1.

107.06 - Safety, Health, and Sanitation Provisions

Provisions regarding Safety, Health, and Sanitation are contained in Section 2.3, Book 2 of the Contract Documents.

107.07 - Public Convenience and Safety

Construction shall be conducted so obstructions to traffic are minimized. The safety and convenience of the public and the protection of persons and property shall be provided as specified in the Transportation Management Plan Section, Book 2 of the Contract Documents.

107.08 - Railroad-Highway Provisions

The railroad-highway provisions are incorporated herein with the following revision:

Delete the first paragraph and replace with the following:

If the Contract requires Materials to be hauled across railroad tracks, the Contractor shall make arrangements with the Railroad for any new crossings required or for the use of any existing crossings.

107.15 - Responsibility for Damage Claims

Provisions regarding responsibility for damage claims are set forth in Book 1, Sections 3.3, 5.6, 9.2, and 11.1 of the Contract Documents.

107.16 - Opening Sections of Project to Traffic

The Provisions regarding opening sections of Project to traffic are deleted except as follows:

1. Opening certain sections of the Work for traffic use shall not constitute acceptance of the Work, or provide a waiver of any provision of the Contract Documents.

107.17 - Contractor's Responsibility for Work

Provisions regarding Contractor's responsibility for Work are set forth in Book 1, Section 2 of the Contract Documents.

107.19 - Furnishing Right of Way

The provisions regarding right-of-way for the Project are set forth in Book 1, Section 6.1and the Right-of-Way Section, Book 2 of the Contract Documents.

107.20 - Personal Liability of Public Employees

The employees of CDOT or authorized representatives are acting solely as agents and representatives of CDOT when carrying out and exercising the power or authority granted to them under the Contract Documents. There shall not be any liability on them either personally or as employees of CDOT.

107.21 - No Waiver of Legal Rights

Provisions regarding no waiver of legal rights are set forth in Book 1, Sections 2, 5 and 20 of the Contract Documents.

107.22 - Third Party Beneficiary

Provisions regarding third party beneficiaries are set forth in Book 1, Section 7.5 of the Contract Documents.

107.23 - Archaeological and Paleontological Discoveries

Provisions regarding archaeological and paleontological discoveries are set forth in Book 1, Section 5 and 13 and the General Section, Book 2 of the Contract Documents.

108 - Prosecution and Progress

108.01 - Subletting of Contract

Provisions regarding Subcontracts are set forth in Book 1, Section 7 of the Contract Documents.

108.02 - Notice to Proceed

Provisions for notice to proceed are set forth in Book 1, Sections 4 and 11of the Contract Documents.

108.03 - Schedule

Provisions regarding progress schedules are set forth in Book 1, Section 4 and the Project Management Section, Book 2 of the Contract Documents.

108.04 – Payment Schedule

Provisions regarding the Contractor's Payment Schedule are set forth in Book 1 Section 11.0 and the Project Management Section, Book 2 of the Contract Documents.

108.08 – Determination and Extension of Contract Time

Provisions regarding Completion Deadlines are set forth in Book 1, Section 4of the Contract Documents; provisions for extensions of such deadlines are set forth in Book 1, Section 13 of the Contract Documents; provisions regarding time for construction operations are set forth in the Transportation Management Plan Section, Book 2 of the Contract Documents.

108.09 - Failure to Complete Work on Time

Provisions regarding Damages for late completion are set forth in Book 1, Section 17 of the Contract Documents.

108.10 - Default of Contract

Provisions regarding default of Contract are set forth in Book 1, Section 16 of the Contract Documents.

108.11 - Termination of Contract

Provisions regarding termination of Contract are set forth in Book 1, Sections 15 and 16 of the Contract Documents.

109 - Measurement and Payment

109.02 - Scope of Payment

Provisions regarding scope of payment are set forth in Book 1, Sections 11 and the Project Management Section, Book 2 of the Contract Documents.

109.04 - Compensation for Changes and Force Account Work

Provisions for compensation for changes in the Work are set forth in Book 1, Section 13 of the Contract Documents.

109.05 - Eliminated Items

Provisions regarding eliminated items are set forth in Book 1, Section 13 of the Contract Documents..

109.06 - Partial Payments

Provisions regarding retainage and securities in lieu of retainage are fully incorporated herein. Monthly payments will be based on the requirements set forth in Book 1, Section 11and the Project Management Section, Book 2 of the Contract Documents.

Notwithstanding the provisions of Book 1, Section 11.6, prior estimates and payments made in accordance with this Subsection 109.06(f) shall not be subject to correction in the Final Payment.

109.07 - Payment for Material On Hand (Stockpiled Materials)

Provisions regarding payment for stockpiled structural steel are fully incorporated herein. Other provisions regarding payment for Materials on hand (stockpiled Materials) are set forth in Book 1, Section 11 of the Contract Documents.

109.09 - Acceptance and Final Payment

Provisions regarding acceptance and final payment are set forth in Book 1, Section 11 of the Contract Documents.

109.10 - Compensation for Compensable Delays

Provisions regarding compensation for compensable delays are set forth in Book 1, Section 13 of the Contract Documents.

20.1.2 Modifications to Section 200 to 700 of the Standard Specifications for Road and Bridge Construction and Standard Special Provisions

20.1.2.1 Modifications to Section 200 to 700 of the Standard Specifications for Road and Bridge Construction

Sections 200 through 700 are incorporated herein except as otherwise provided in the Contract Documents, with the following exceptions: (1) in Sections 200 through 600, the method of measurement and basis of payment provisions are superseded by the provisions set forth in Books 1 and 2 of the Contract Documents.

20.1.3 Standard Special Provisions

The following Standard Special Provisions are to be used by the Contractor for Design and Construction of the Work. The Standard Special Provisions are Revisions to the 2011 Standard Specifications for Road and Bridge Construction.

Standard Special Provision Index: February 18, 2016

The following Standard Special Provisions are available at the following link:

https://codot.gov/business/designsupport/2011-construction-specifications/2011-Specs/standard-special-provisions/SSP-Index.docx/view

Name	Date	No. of Pages
Revision of Sections 101, 508, 614, and 710 – Treated Timber	(July 31, 2014)	1
Revision of Section 101 and 630 – Construction Zone Traffic Control	(April 30, 2015)	2
Revision of Section 105 – Construction Surveying	(July 31, 2014)	1
Revision of Section 105 – Contractor Submittals Traffic Signal Pedestal Pole	(February 3, 2011)	1
Revision of Section 105 – Disputes and Claims for Contract Adjustments	(October 29, 2015)	33
Revision of Section 105 – Hot Mix Asphalt Pavement Smoothness	(May 8, 2014)	7
Revision of Section 105 – Portland Cement Concrete Pavement Smoothness 1	(February 18, 2016)	
Revision of Section 105 – Conformity to the Contract of Hot Mix Asphalt (Less than 5000 Tons)	(January 15, 2015)	8
Revision of Section 105 – Conformity to the Contract of Hot Mix Asphalt (Voids Acceptance)	(January 15, 2015)	10
Revision of Sections 105, 106, 412, 601 and 709 - Conformity to the Contract of Portland Cement Concrete		

Pavement and Dowel Bars and Tie Bars for Joints	(April 30, 2015)	24
Revision of Section 106 – Buy America Requirements	(November 6, 2014)	1
Revision of Section 106 – Certificates of Compliance and Certified Test Reports	(February 3, 2011)	1
Revision of Section 106 – Material Sources	(October 31, 2013)	1
Revision of Section 106 – Supplier List	(January 30, 2014)	1
Revision of Sections 106 and 412 – Surface Texture of Portland Cement Concrete	(October 29, 2015)	3
Revision of Sections 106, 627 and 713 - Glass Beads for Pavement Marking	(February 8, 2013)	2
Revision of Section 107 – Contractor Obtained Stormwater Construction Permit	(July 31, 2014)	1
Revision of Section 107 – Project Payrolls	(May 2, 2013)	1
Revision of Section 107 - Responsibility for Damage Claims, Insurance Types, and Coverage Limits	(February 3, 2011)	1
Revision of Section 107 – Warning Lights for Work Vehicles and Equipment	(January 30, 2014)	1
Revision of Sections 108 and 109 - Payment Schedule (Multiple Fiscal Years)	(April 30, 2015)	1
Revision of Section 109 – Measurement of Quantities	(February 3, 2011)	1
Revision of Section 109 – Measurement of Water	(January 06, 2012)	1
Revision of Section 109 – Prompt Payment	(January 31, 2013)	1
Revision of Section 203 – Imported Material for Embankment	(February 3, 2011)	2
Revision of Sections 203, 206, 304 and 613 - Compaction	(July 19, 2012)	2
Revision of Section 206 – Imported Material for Structure Backfill	(July 19, 2012)	2
Revision of Section 206 – Structure Backfill (Flow-Fill)	(April 26, 2012)	2
Revision of Section 206 – Structure Backfill at Bridge Abutments	(January 30, 2014)	1
Revision of Section 206 and 601 – Maturity Meters and Concrete Form and Falsework Removal	(December 18, 2015)	3
Revision of Section 208 – Aggregate Bag	(January 31, 2013)	1
Revision of Section 208 – Erosion Control Supervisor	(April 30, 2015)	1
Revision of Section 208 – Erosion Log	(January 31, 2013)	1
Revision of Section 212 – Seed	(April 26, 2012)	1
Revision of Section 213 – Mulching	(January 31, 2013)	4
Revision of Section 216 – Soil Retention Covering	(July 16, 2015)	6
Revision of Section 250 – Environmental, Health and Safety Management	(January 15, 2015)	14
Revision of Section 401 – Compaction of Hot Mix Asphalt	(April 26, 2012)	1
Revision of Section 401 – Compaction Pavement Test Section (CTS)	(July 19, 2012)	1
Revision of Section 401 – Composition of Mixtures – Voids Acceptance	(February 3, 2011)	1
Revision of Section 401 – Plant Mix Pavements	(February 3, 2011)	1
Revision of Section 401 – Reclaimed Asphalt Pavement	(May 2, 2013)	2
Revision of Section 401 – Temperature Segregation	(February 3, 2011)	1
Revision of Section 401 – Tolerances for Hot Mix Asphalt (Voids Acceptance)	(January 6, 2012)	1
Revision of Section 401 and 412 – Safety Edge	(May 2, 2013)	2
Revision of Section 412 – Portland Cement Concrete Pavement Finishing	(February 3, 2011)	1
Revision of Sections 412, 601, and 711 - Liquid Membrane-Forming		

Compounds for Curing Concrete	(May 5, 2011)	1
Revision of Sections 412 and 705 – Preformed Compression Seals	(February 3, 2011)	2
Revision of Section 504 – Concrete Panel Facing MSE Wall	(February 3, 2011)	12
Revision of Section 507 – Grouted Riprap Slope and Ditch Paving	(November 6, 2014)	1
Revision of Section 507, 601, and 606 – Macro Fiber-Reinforced Concrete	(May 2, 2013)	1
Revision of Section 510 – Structural Plate Structures	(February 3, 2011)	1
Revision of Section 512 – Bearing Device Testing	(November 6, 2014)	1
Revision of Section 518 - Bridge Expansion Device	(October 31, 2013)	1
Revision of Section 601 – Class B, BZ, D, DT, and P Concrete	(February 18, 2016)	2
Revision of Section 601 – Class H and HT Bridge Deck Concrete	(May 16, 2013)	4
Revision of Section 601 – Concrete Batching	(February 3, 2011)	1
Revision of Section 601 – Concrete Finishing	(February 3, 2011)	1
Revision of Section 601 – Concrete Slump Acceptance	(October 29, 2015)	1
Revision of Section 601 – Depositing Concrete Under Water	(May 2, 2013)	1
Revision of Section 601 - Entrained Air of Class BZ Concrete	(April 30, 2015)	1
Revision of Section 601 – Fiber-Reinforced Concrete	(February 18, 2016)	1
Revision of Section 601 – QC Testing Requirements for Structural Concrete	(May 8, 2014)	1
Revision of Section 601 – Structural Concrete Strength Acceptance	(April 30, 2015)	1
Revision of Sections 601 and 701 – Cements and Pozzolans	(November 6, 2014)	4
Revision of Section 603 – Culvert Pipe Inspection	(October 2, 2014)	1
Revision of Sections 603, 624, 705, 707, and 712 – Drainage Pipe	(April 30, 2015)	3
Revision of Section 612 – Delineators	(February 3, 2011)	1
Revision of Section 612 – Flexible Delineators	(July 19, 2012)	1
Revision of Sections 613 and 715 – LED Roadway Luminaire	(January 30, 2014)	5
Revision of Section 614 – Accessible Pedestrian Signal	(November 1, 2012)	3
Revision of Section 614 – Blank Out Sign (LED) (Speed Radar)	(Dec. 29, 2011)	6
Revision of Section 614 – Pedestrian Push Button Assembly	(July 19, 2012)	1
Revision of Section 618 – Prestressed Concrete	(April 26, 2012)	24
Revision of Section 620 – Field Laboratories with Ignition Furnace	(February 3, 2011)	1
Revision of Section 627 and 708 – Pavement Marking Paint	(January 31, 2013)	2
Revision of Section 630 - Emergency Pull-off Area (Temporary)	(May 5, 2011)	1
Revision of Section 630 – Retroreflective Sign Sheeting	(May 8, 2014)	1
Revision of Section 630 - Rolling Roadblock	(November 1, 2012)	2
Revision of Section 630 – Temporary Portable Rumble Strip	(February 18, 2016)	1
Revision of Section 702 – Bituminous Materials	(October 29, 2015)	11
Revision of Section 703 - Aggregate for Bases (Without RAP)	(October 31, 2013)	1
Revision of Section 703 – Aggregate for Hot Mix Asphalt	(November 1, 2012)	2
Revision of Section 703 – Aggregate for Stone Matrix Asphalt	(April 26, 2012)	1
Revision of Section 703 – Concrete Aggregate	(July 28, 2011)	1
Revision of Section 703 – Mineral Filler	(May 8, 2014)	1
Revision of Section 709 – Epoxy Coated Reinforcing Bars	(February 18, 2016)	1
Revision of Section 712 – Geotextiles	(November 1, 2012)	2
Revision of Section 712 – Water for Mixing or Curing Concrete	(February 3, 2011)	1
Revision of Section 713 - Epoxy Pavement Marking	(January 15, 2015)	2
Revision of Section 713 – Reflectors for Delineators and Median Barrier	(May 2, 2013)	1