CITY AND COUNTY OF DENVER
SPECIAL PROVISIONS
NTS NORTHEAST – CP2
2024-PROJMSTR-0000489

General Contract Conditions shall be the City and County of Denver, Department of Public Works, “Standard Specifications for Construction General Contract Conditions”, 2016 edition and hereinafter modified shall be used for this project.

STANDARD CONSTRUCTION SPECIFICATIONS

The Standard Specifications for Construction for this Project shall consist of the applicable sections and subsections, numbered Section 200 through Section 700, of the 2023 "Colorado Department of Transportation Standard Specifications for Road and Bridge Construction."

The Colorado Department of Transportation General Provisions consists of Sections 100 through 109 of the above-mentioned specifications. With the exception of General Provision Sections 101, 105, 106, 107 and 108, all other General Provisions are not applicable to this Project and are hereby deleted. In place of the deleted sections, the City and County of Denver “Standard Specifications for Construction, General Contract Conditions,” 2016 Edition, shall apply to this contract. Supplements or amendments to the Standard Specifications for Construction, General Contract Conditions are listed in the Special Contract Conditions.

The following Project Special Provisions take precedence over Specifications or Plans and supplement or amend the referenced” Standard Specifications for Road and Bridge Construction” adopted in 2023 by the Colorado Department of Transportation, which is to be used to control construction of this Project.

DETAILED CONSTRUCTION SPECIFICATIONS

The Detailed Specifications for this project are defined in the City of Denver Contract Requirements and Contract Documents.

DENVER PARKS AND RECREATION CONSTRUCTION SPECIFICATIONS

The Detailed Specifications for the portions of this project that take place within a Denver Park or locations maintained by Denver Parks & Recreation are defined in the City of Denver Parks and Recreation Technical Specifications. The current revision of Denver Parks and Recreation Specifications shall supersede other CCD or CDOT specifications for work conducted within Park boundaries or areas maintained by Denver Parks and Recreation.

CITY AND COUNTY OF DENVER
SPECIAL PROVISIONS
NTS NORTHEAST – CP2
2024-PROJMSTR-0000489

STANDARD CONSTRUCTION DETAILS

It is the intent of the City to use applicable details from the Colorado Department of Transportation M&S Standards, the City of Denver's Wastewater Management Division Standard Details, and the Denver Water Department's Standard Drawings, most recent editions. Drainage related appurtenances shall follow the City and County of Denver (CCD), Department of Department of Transportation & Infrastructure document titled "Storm Drainage and Sanitary Sewer Construction Detail and Technical Specifications". This document can be found at the following web address:
https://www.denvergov.org/content/dam/denvergov/Portals/711/documents/StormMasterPlan/StormDrainageDesignTechnicalCriteria.pdf

City and County of Denver DOTI Rules & Regulations, Permits, Engineering Policy Statements and Standards, Details, Manuals, Studies & Guidelines can be found on the DOTI Document Center webpage.
https://www.denvergov.org/content/denvergov/en/transportation-infrastructure/documents.html

Select materials to be used in the ROW from CDOT or CCD's pre-approved materials list. CCD's list can be found at the link below. See the Materials drop-down at the bottom of the page:
https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Department-of-Transportation-and-Infrastructure/Programs-Services/Right-of-Way-Services/Street-Occupancy

PROJECT SPECIAL PROVISIONS
NTS NORTHEAST – CP2
2024-PROJMSTR-0000489

The Colorado Department of Transportation's Standard Specifications for Road and Bridge Construction, dated 2023, controls construction of this project. City and County of Denver (CCD) Department of Transportation & Infrastructure (DOTI) standards and specifications take precedence over CDOT standards and specifications. The following special provisions supplement or modify the Standard Specifications and take precedence over the Standard Specifications and plans.

PROJECT SPECIAL PROVISIONS

		Page
Front-end & Index Pages	(Nov. 19, 2025)	1 – 6
Commencement and Completion of Work	(Nov. 19, 2025)	7
Revision of Section 101 – Definitions and Terms	(Nov. 19, 2025)	8
Revision of Section 102 – Project Plans and other Data	(Nov. 19, 2025)	9
Revision of Section 105 – Contractor Submittals	(Nov. 19, 2025)	10 - 11
Revision of Section 105 – Cooperation Of The Contractor	(Nov. 19, 2025)	12
Revision of Section 107 – Performance of Safety Critical Work	(Nov. 19, 2025)	13 - 15
Revision of Section 107 – Worker Safety	(Nov. 19, 2025)	16
Revision of Section 107 – Protection of Existing Vegetation	(Nov. 19, 2025)	17
Revision of Section 201 – Clearing and Grubbing	(Nov. 19, 2025)	18 - 19
Revision of Section 202 – Removal of Structures, Asphalt Mat and Obstructions	(Nov. 19, 2025)	20 - 22
Revision of Section 203 – Potholing	(Nov. 19, 2025)	23
Revision of Section 208 – Sweeping (Sediment Removal)	(Nov. 19, 2025)	24
Revision of Section 208 – Erosion Control	(Nov. 19, 2025)	25 – 40
Revision of Section 209 – Watering & Dust Palliatives	(Nov. 19, 2025)	41
Revision of Section 210 – Reset Structures	(Nov. 19, 2025)	42 – 43
Revision of Section 250 – Environmental, Health and Safety Management	(Nov. 19, 2025)	44 – 45
Revision of Section 503 – Drilled and Vacuumed Caisson	(Nov. 19, 2025)	46
Revision of Section 608 – Sidewalks, Curb Ramps and Bikeways	(Nov. 19, 2025)	47 – 49
Revision of Section 609 – Curb and Gutter	(Nov. 19, 2025)	50 – 51
Revision of Section 610 – Median Cover Material	(Nov. 19, 2025)	52 – 53
Revision of Section 612 – Directional Indicator Strip	(Nov. 19, 2025)	54
Revision of Section 613 – Electrical Conductor Identification	(Nov. 19, 2025)	55
Revision of Section 613 – Electrical Conduit – General	(Nov. 19, 2025)	56 – 58
Revision of Section 613 – Electric Meter Pedestal Cabinet and Base	(Nov. 19, 2025)	59
Revision of Section 613 – Lighting (Luminaire)	(Nov. 19, 2025)	60
Revision of Section 613 – Pull Boxes – General	(Nov. 19, 2025)	61

PROJECT SPECIAL PROVISIONS
NTS NORTHEAST – CP2
2024-PROJMSTR-0000489

Revision of Section 614 – LED Pedestrian Signal Face (16) (Countdown)	(Nov. 19, 2025)	62
Revision of Section 614 – Traffic Control Devices	(Nov. 19, 2025)	63 – 66
Revision of Section 614 – Traffic Signal Backplate	(Nov. 19, 2025)	67
Revision of Section 614 – Accessible Pedestrian Signal	(Nov. 19, 2025)	68 – 72
Revision of Section 614 – Traffic Signal Controller and Cabinet	(Nov. 19, 2025)	73 – 80
Revision of Section 614 – Traffic Signal Cabinet Base	(Nov. 19, 2025)	81
Revision of Section 614 – Pedestrian Push Button Post Assembly	(Nov. 19, 2025)	82
Revision of Section 614 – Emergency Vehicle Traffic Signal Priority Control System	(Nov. 19, 2025)	83 – 89
Revision of Section 614 – Traffic Signal Poles – General	(Nov. 19, 2025)	91 – 92
Revision of Section 614 – Uninterrupted Power Supply System	(Nov. 19, 2025)	93 - 111
Revision of Section 614 – Fiber Optic Cable (Single Mode)	(Nov. 19, 2025)	112 – 120
Revision of Section 614 – Closed Circuit Television Camera (Traffic Surveillance)	(Nov. 19, 2025)	121 - 122
Revision of Section 614 – Test Fiber Optic Cable	(Nov. 19, 2025)	123 – 129
Revision of Section 614 – Ethernet Managed Switch	(Nov. 19, 2025)	130 – 131
Revision of Section 614 – Grounding and Bonding	(Nov. 19, 2025)	132 – 137
Revision of Section 623 – Irrigation System	(Nov. 19, 2025)	138
Revision of Section 625 – Construction Surveying	(Nov. 19, 2025)	139 - 141
Revision of Section 626 – Mobilization	(Nov. 19, 2025)	142
Revision of Section 627 – Pavement Marking	(Nov. 19, 2025)	143
Revision of Section 629 – Survey Monumentation	(Nov. 19, 2025)	144 - 146
Revision of Section 630 – Uniformed Traffic Control	(Nov. 19, 2025)	147
Revision of Section 630 – Construction Traffic Control	(Nov. 19, 2025)	148 – 154
Allowance Items	(Nov. 19, 2025)	155
Special Construction Requirements: Traffic Signal Installation Personnel Requirement	(Nov. 19, 2025)	156
Utilities	(Nov. 19, 2025)	157 – 163
Denver (Only) Noise Ordinance Permit Variance Application Template	(Nov. 19, 2025)	164 - 169
Appendix A: MMP – Draft Template and MMP Checklist	(Nov. 19, 2025)	A1 – A19
Appendix B: Regulated Asbestos Contaminated Soil Standard Operation Procedure	(Nov. 19, 2025)	B1 – B76
Appendix C: Guidance for Reuse of Soil on City Projects	(Nov. 19, 2025)	C1 – C7

PROJECT SPECIAL PROVISIONS
NTS NORTHEAST – CP2
2024-PROJMSTR-0000489

DENVER PARKS AND RECREATION TECHNICAL SPECIFICATIONS

		No. Pages
Section 01 56 39 – Tree Retention and Protection	(Jan. 2023)	13
Section 01 71 23 – Layout of Work and Surveys	(Jan. 2025)	3
Section 02 41 00 – Demolition	(Jan. 2025)	5
Section 31 11 00 – Clearing and Grubbing	(Jan. 2025)	5
Section 32 13 13 – Concrete Walks, Curbs, and Miscellaneous Flatwork	(Jan. 2025)	17
Section 32 80 00 – Irrigation Systems	(Jan. 2023)	22
Section 32 92 20 – Native Seeding	(Jan. 2023)	25
Section 32 92 23 – Sodding	(Jan. 2025)	11

PROJECT SPECIAL PROVISIONS
NTS NORTHEAST – CP2
2024-PROJMSTR-0000489

CDOT STANDARD SPECIAL PROVISIONS (2023)

		No. Pages
Revision of Section 101 – Definitions and Section 106 – Control of Materials	(Jan. 8, 2024)	2
Revision of Sections 101 and 106 – Buy America and Build America, Buy America Requirements – No-Federal Aid	(Jan. 8, 2024)	4
Revision of Section 103 – Colorado Resident Bid Preference	(Oct. 1, 2023)	1
Revision of Section 105 – Control of Work	(Oct. 1, 2023)	1
Revision of Section 105 – Dispute Review Board and Claims for Unresolved Disputes	(Oct. 1, 2023)	9
Revision of Section 105 – E-Signature	(Jan. 8, 2024)	1
Revision of Section 105 – Pavement Smoothness	(Jul. 1, 2024)	11
Revision of Section 106 – Check Testing	(Oct. 1, 2023)	1
Revision of Section 106 – Control of Material	(Sep. 30, 2024)	1
Revision of Section 401 – Plant Mix Pavements – General (Subsection 401.17)	(Jan. 8, 2024)	4
Revision of Section 401 – Plant Mix Pavements – General (Subsection 401.10)	(Sep. 30, 2024)	1
Revision of Section 401 – Tolerances for Hot Mix Asphalt (Voids Acceptance)	(Oct. 1, 2023)	1
Revision of Section 412 – Powered Screeds	(Dec. 26, 2024)	1
Revision of Section 601 – Concrete Acceptance	(Apr. 9, 2024)	4
Revision of Section 713 – Retroreflectors and Drum and Tubular Marker Sheeting Requirements	(Dec. 26, 2024)	4
Revision of Section 715 – Conduit and Pull Box Revisions	(Dec. 26, 2024)	1
Affirmative Action Requirements Equal Employment Opportunity	(Oct. 1, 2023)	13
Minimum Wages, Colorado, U.S. Department of Labor General Decision Number CO20250009, Highway Construction for Denver and Douglas Counties	(Jan. 3, 2025)	5

Commencement and Completion of Work

Section 108 of the Standard Specifications is hereby revised for this project as follows:

Subsection 108.03 shall include the following:

The Contractor's progress schedule may be a Bar Chart Schedule. Salient features to be shown on the Contractor's Progress Schedule are:

1. Notice to Proceed
2. Mobilization(s)
3. Erosion Control
4. Removals
5. Curb and Gutter, Median Cover Material, Curb Ramps
6. Sidewalk
7. Traffic Signal
8. Signing and Striping
9. Construction Traffic Control
10. Landscape Restoration

Revision of Section 101
Definitions and Terms

Section 101 of the Standard Specifications is hereby revised for this project as follows:

Technical Specifications related to construction materials and methods for the Work under this Contract shall consist of the State Department of Highways, Division of Highways, State of Colorado, Standard Specifications for Road and Bridge Construction dated 2011.

Certain terms utilized in the Specifications referred to in the paragraph above shall be interpreted to have different meaning within the scope of this Contract. A summary of redefinitions follows:

Subsection 101.28 **"Department"** shall mean the City and County of Denver, Colorado.

Subsection 101.29 **"Engineer"** shall mean the Director of Denver Department of Transportation & Infrastructure, or designated representative.

Subsection 101.39 **"Laboratory"** shall mean City and County of Denver, Colorado or their designated representative.

Subsection 101.51 **"Project Engineer"** shall mean the Director of Denver Department of Transportation & Infrastructure, or designated representative.

Subsection 101.76 **"State"** shall mean City and County of Denver, Colorado (where applicable).

Revision of Section 102
Project Plans and Other Data

Revise Section 102 of the Standard Specifications for this project as follows:

Subsection 102.05 shall include the following:

Supplemental data is provided in DWG file formats. The supplemental data transmitted consists of:

1. Civil 3D Files
   (a) Existing Terrain
   (b) Proposed Terrain
2. Existing DWG files:
   (a) Existing Right of Way
   (b) Existing Topography and Survey
3. Proposed DWG files:
   (a) Proposed Curb Ramp Design
   (b) Proposed Traffic Design
   (c) Proposed Erosion Control Design

The City does not warrant the supplemental data and this information is not considered to be a part of the Contract. If bidders use or modify the supplemental data in preparing a proposal or planning and prosecuting the work, all associated data is used at their own risk, and bidders are responsible for all conclusions, deductions, and inferences drawn from the original or modified supplemental data.

After the proposals have been opened, the low responsible bidder may obtain electronic plans and special provisions from the City Project Manager.

1

Revision of Section 105
Contractor Submittals

Section 105 of the Standard Specifications is hereby revised for this project to include the following:

Only submittals applicable to the project are required.

In subsection 105.02, Table 105-1 shall include the following:

Section No.	Description	Type	Contractor P.E. Seal Required?
613	Luminaires	Shop Drawing	No
613	Photometric Analysis	Working Drawing	No
614	Traffic signal controller	Shop Drawing	No
614	Traffic signal controller cabinet	Shop Drawing	No
614	Traffic signal controller cabinet base	Shop Drawing	No
614	Load switches	Shop Drawing	No
614	Conflict monitors	Shop Drawing	No
614	Flashers	Shop Drawing	No
614	Isolators	Shop Drawing	No
614	Uninterruptible power supply	Shop Drawing	No
614	Cameras	Shop Drawing	No
614	Visors	Shop Drawing	No
614	Pedestrian signal face (16) (countdown)	Shop Drawing	No
614	Pedestrian signal head	Shop Drawing	No
614	Traffic signal head, including configurations	Shop Drawing	No
614	Traffic Signal-Light Pole Steel	Shop Drawing	No*
614	Traffic signal back plates	Shop Drawing	No
614	Traffic signal face	Shop Drawing	No
614	Pedestrian signs	Shop Drawing	No
614	Pedestrian detectors	Shop Drawing	No
614	Pedestrian push button poles	Shop Drawing	No
614	Intersection detection system components	Shop Drawing	No
614	Electric meter/disconnect	Shop Drawing	No
614	Pre-emption devices	Shop Drawing	No
614	Mounting hardware	Shop Drawing	No
614	Signal head back plates	Shop Drawing	No
614	Street name signs	Shop Drawing	No
614	Pull boxes	Shop Drawing	No
614	Wire	Shop Drawing	No

2

Revision of Section 105
Contractor Submittals

Section No.	Description	Type	Contractor P.E. Seal Required?
614	Fiber optic cable (including interconnect schematic diagram)	Shop Drawing	No
614	Mix design	Shop Drawing	No
614	Conduits (including elbows)	Shop Drawing	No
614	Polypipe	Shop Drawing	No
614	Optic cards, heads, and cabling	Shop Drawing	No
614	Termination panels	Shop Drawing	No
614	Ethernet switch, patch cables, and connectors	Shop Drawing	No
614	Splice kits	Shop Drawing	No
614	Splice enclosures	Shop Drawing	No
614	Telemetry	Shop Drawing	No
614	Grounding and bonding system plan, supports, connectors, and rods	Shop Drawing	No

* Stamp for Traffic Signal-Light Pole Steel required from the Manufacturer.

Revision of Section 105
Cooperation of the Contractor

Section 105 of the Standard Specifications is hereby revised for this project as follows:

Subsection 105.10 shall include the following:

All work orders on this On-Call shall be initiated by an RFP from the City and County of Denver. Once an RFP is submitted to the Contractor from the City and County of Denver, the Contractor shall have 10 business days to reply with a scope and fee for the RFP.

Other construction agencies may be working in the vicinity of the project. The Contractor shall conduct the work so as not to interfere with or hinder the progress or completion of the work being performed by other agencies or contractors. All traffic control conflicts that arise between the needs of the various construction contractors and other agencies shall be brought to the attention of the Engineer. The Engineer will decide the method of resolution.

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 erection
(2) Overhead structure construction or repair
(3) temporary works: falsework, shoring that exceeds 5 feet in height, cofferdams, and temporary bridges
(4) Work requiring the use of cranes or other lifting equipment

The Contractor shall submit, for record purposes only, an initial detailed construction plan that addresses safe construction of each of the safety critical elements. An erection 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. The construction plan will not be approved by the Engineer.

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:
    D. Unplanned events (storms, traffic accidents, etc.)
    E. Structural elements that don't fit or line up
    F. Work that cannot be completed in time for the roadway to be reopened to traffic

2
Revision of Section 107
Performance of Safety Critical Work

G. Replacement of workers who don't perform the work safely
H. Equipment failure
I. 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 Engineer in writing when it is safe to open a route to traffic after it has been closed for safety critical work.

A safety critical element conference shall be held two weeks prior to beginning construction on each safety critical element. The Engineer, the Contractor, the safety critical element subcontractors, and the Contractor's Engineer shall attend the conference. Required pre-erection 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 shall sign and seal temporary works related to construction plans for the safety critical elements, and Temporary Works. The final construction plan shall be stamped "Approved for Construction" and signed by the Contractor.

The Contractor shall perform safety critical work only when the Engineer is on the project site. The Contractor's Engineer shall be on site to inspect and provide written approval of safety critical work for which he provided stamped construction details. Unless otherwise directed or approved, the Contractor's Engineer 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 Engineer, 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 Engineer will authorize resumption of the work.

When ordered by the Engineer, 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

3
Revision of Section 107
Performance of Safety Critical Work

the submitted plan, he shall submit a revised plan to the Engineer 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 City and County of Denver.

Revision of Section 107
Worker Safety

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

Subsection 107.06 shall include the following:

Contractors shall comply with the CCD Noise Control Ordinance for all construction activities scheduled to occur between the hours of 9:00 p.m. to 7:00 a.m. Monday – Friday and 5:00 p.m. and 8:00 a.m. Saturday through Sunday if noise levels are expected to exceed 50 dBA in residential areas or 60 dBA in commercial areas. Nighttime construction activities exceeding noise levels during these restricted hours may not be initiated without first obtaining this permit variance from CCD.

Under any circumstances where nighttime construction activities will take place between the restrictive hours listed above where noise levels will exceed the noise impact thresholds, the contractor is required to apply for a construction noise variance no less than one month before the startup date for construction. Note: the CCD board only meets the 2nd Thursday of every month.

Applications shall be submitted through the Denver Department of Environmental Health (DEH) at a cost of $25.00 for application processing.

The contractor is responsible for fulfilling the requirements set forth by the CCD and is responsible for obtaining the permit variance prior to the construction startup date. All exemption requests and permitting requirements will not be paid for separately but will be included in the work. Copies of the final application approval shall be provided to CDOT R6 Noise Specialist (Jordan Rudel) for recording and documentation purposes demonstrating compliance with the local agencies' regulations.

If the Contractor is ordered to cease operations due to violations of a noise ordinance as a result of equipment back up alarms, the Contractor shall take whatever actions are necessary to comply with the ordinance and continue work on the project. This includes the option of using an observer in lieu of using the equipment's back up alarms as allowed by 29 CFR 1926.601(b) (4) (II) of the OSHA Safety and Health Standards. Should the Contractor fail to mitigate the noise ordinance violation, the Contractor shall be deemed to have waived any right to a claim as a result of work suspension or being required to perform the work at times not specified in the Contract.

If the Contractor uses an observer in lieu of back up alarms, the Contractor shall follow all of the OSHA requirements regarding the use of observers.

All costs incidental to the foregoing requirements shall be included in the original contract prices for the project.

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 vegetation (including trees, shrubs, ground covers, grasses, wetlands & riparian) 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 the drip line of the tree or as approved by the Engineer. Equipment shall not be installed or stockpile material 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, shrubs beyond replaceable size or wetlands 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 calculated according to the following formula:

(Vegetation size) x (Species) x (Location) x (Condition) x (Arborist or Wetland Specialist) = Vegetation value

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 City's Landscape Architect or Wetland Specialist. Contact Jim Myers at CCD Forestry Department.

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.

1

Revision of Section 201
Clearing and Grubbing

Section 201 of the Standard Specifications is hereby revised to include:

Subsection 201.02, paragraph 2 shall be deleted and replaced with the following:

Removals shall be completed to the proposed subgrade elevation for the work, or as designated by the Engineer.

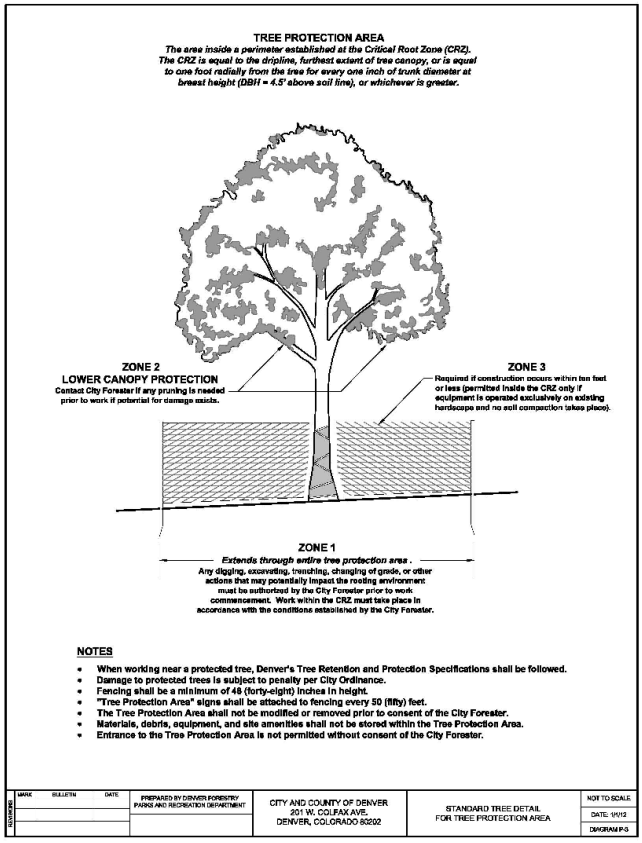
Removal of trees with less than a 4-inch diameter, when measured 24 inches or less above the existing grade, will not be measured and paid for separately. These tree removals will be included in the clearing and grubbing work.

Subsection 201.02, paragraph 8 shall be deleted and replaced with the following:

All tree trimming will be performed by the City and County of Denver through the City Forester's Office. Contact Jim Myers two (2) days prior.

Subsection 201.02 is hereby revised to include:

All trees designated to remain shall be protected in accordance with Denver's Standard Detail for Tree Protection Area – see detail.



2
Revision of Section 201
Clearing and Grubbing

Subsection 201.03 is hereby revised to include:

Clearing and grubbing will not be measured and paid for separately but shall be included in the cost of the work.

Tree protection will not be measured and paid for separately but shall be included in the cost of the work.

1
Revision of Section 202
Removal of Structures, Asphalt Mat and Obstructions

Section 202 of the Standard Specifications is hereby revised as follows:

Subsection 202.02 shall be revised to include the following:

The Engineer will mark the limits of removals in the field. Removals in the vicinity of trees to remain shall conform to applicable provisions of the Denver Forestry's Tree Protection specification.

Subsection 202.03 is hereby replaced as follows:

All salvable material shown on the plans shall be removed, without unnecessary damage, in sections or pieces that may be readily transported, and delivered by the Contractor to the location noted on the plans, or as directed by the Engineer. The Contractor shall be held responsible for the safekeeping of all salvable materials during the period of the Contract until they are delivered to the City. The Contractor shall make good or replace at his own expense any such materials damaged, stolen or otherwise lost prior to receipt by the City. All salvable materials, as designated on the plans, shall remain the property of the City.

Subsection 202.07 is hereby replaced as follows:

All concrete pavement, sidewalks, structures, curbs, gutters, asphalt pavement, etc., designated for removal, shall be broken into pieces and disposed of outside the limits of the project, unless otherwise designated on the plans, or as directed by the Engineer.

Old concrete construction which abuts new construction, edges of pavement, sidewalks, curbs, etc., to be left in place shall be saw cut to true line with a vertical face.

Where old asphalt construction abuts new construction, edges of asphalt pavement, patching, etc., asphalt to be left in place shall be wheel cut or sawcut to a neat vertical face with minimal jagged edges to the satisfaction of the Engineer. The Engineer, at his discretion, may require asphalt to be sawcut.

Removal of stone curb shall include the complete removal of the curb head and concrete foundation. No payment will be made for sprinkler relocation, utility relocation, etc., beyond the limits of construction as shown on the plans. Stone curb designated for salvage shall be carefully removed to prevent damage and delivered to the location indicated in the plans or specifications, or as directed by the Engineer.

2
Revision of Section 202
Removal of Structures, Asphalt Mat and Obstructions

Subsection 202.09 shall be revised to include the following:

Removal of asphalt mat from gutters shall be accomplished by planing, and/or scraping. If the existing gutter is to remain, the gutter shall be cleaned by sandblasting until the pan is completely clean of residue. Gutters which are excessively (greater than one-quarter inch in depth) planed or damaged shall be removed and replaced by the Contractor at his expense. If gutter is designated for removal, no separate payment shall be made for asphalt removal.

Subsection 202.11 shall be revised to include the following:

Removal of concrete paving, crosspans, curb ramps, and driveways will be measured by area in square yards, regardless of thickness, and paid for as removal of sidewalk.

Removal of asphalt mat will be measured by square yard. If the existing asphalt mat is over 9-inches thick, the unit price will be increased in proportion to the additional thickness (18" asphalt mat will be paid at twice the unit price). If the asphalt mat is greater than 4-inches and is over concrete pavement, both asphalt removal and concrete pavement removal will be paid. If the asphalt mat is less than 4-inches and is over concrete pavement, only concrete pavement removal will be paid.

Removal of asphalt mat (planing or milling) will be measured by the square yard, regardless of thickness.

Removal of trolley tracks will be measured by centerline lineal track foot, and shall include the removal of rails, ties, connections, cobblestones and concrete runners.

Removal of asphalt mat from concrete gutter and other concrete designated to remain shall be measured by the square yard. Removal of asphalt mat from gutter shall include sandblasting and compressed air cleaning as part of that pay item.

Remove siphon will be measured as a lump sum for each siphon and shall include: removing the connector pipe, two (2) inlets, grates and frames, any related materials, concrete, metal, sealant, debris, excavation and suitable backfill placed and compacted, all materials, labor equipment, hauling and disposal needed to complete this item.

Subsection 202.12 is hereby deleted and replaced as follows:

The accepted quantities will be paid for at the contract unit price for each of the pay items listed below that appear in the bid schedule. Payment shall be full compensation for sawcutting, scraping, sandblasting, removing, hauling and disposal of such items, excavation and subsequent backfill to proposed subgrade elevation. The price shall also include

3
Revision of Section 202
Removal of Structures, Asphalt Mat and Obstructions

salvageable materials removed, their custody, preservation, storage, haul and disposal as provided herein.

Payment will be made under:

Pay Item	Pay Unit
Removal of Concrete Median Cover Material	SY
Removal of Sidewalk	SY
Removal of Curb	LF
Removal of Gutter	LF
Removal of Curb and Gutter	LF
Removal of Concrete Curb Ramp	SY
Removal of Concrete Pavement	SY
Removal of Asphalt Mat	SY
Removal of Ground Sign	Each

When the Contract does not include pay items for Removal of Structures and Obstructions, the removal will not be paid for separately but shall be included in the work.

Revision of Section 203
Potholing

Section 203 of the Standard Specification is hereby revised for this project as follows:

Subsection 203.05(g) Excavation shall include the following:

The work shall include one (1) pothole per utility per conduit crossing or as approved by the Engineer.

All surface material disturbed by potholing shall be restored in kind in accordance with City standards.

- All potholes must be core drilled.
- All potholes must be backfilled using only one of the following methods:
  - Wet Sand
  - Flowfill
  - Flashfill
  - The Contractor may submit a written request to use a material not specified above (squeegee, pea gravel, and native material will not be allowed)
- Potholes in an asphalt street must be patched back using hot bituminous asphalt, minimum 9-inch in depth.
- Potholes in a concrete street must be patched back with fast curing high strength concrete no less than 8000 psi in 28 days and a 3000 psi in 60 minutes.
- Full concrete panel replacement is required when a third pothole is core drilled in the same panel. The contractor that cut the last pothole (i.e. 3rd) will be required to replace the panel.
- Any pothole in a sidewalk will require a full panel replacement.
- Any pothole in the curb and gutter or any drainage way will require at a minimum, a half panel replacement.

Delete Subsection 203.13(e) and replace with the following:

(e) Potholing. Potholing will be measured by each. All other related work, including removal of existing pavement, backfilling, shoring and labor will not be measured and paid for separately but shall be included in the work.

Subsection 203.14 of the Standard Specifications shall include the following:

Pay Item	Pay Unit
Potholing	Each

Revision of Section 208
Sweeping (Sediment Removal)

Section 208 of the Standard Specification is hereby revised for this project as follows:

Subsection 208.01 shall include the following:

This work is for sweeping paved surfaces during construction as part of the project Best Management Practices (BMP).

Subsection 208.04 shall include the following:

Paved surfaces adjacent to the construction site shall be swept by the close of business day and during the day as needed when sediment and other materials are tracked or discharged onto them. Sweeping shall be completed with a pickup broom or equipment capable of collecting sediment. Sweeping with a kick broom will not be allowed. Street sweepers using water while sweeping is preferred in order to minimize dust. Flushing off paved surfaces with water is prohibited.

Subsection 208.13 shall include the following:

Sweeping, when used as a BMP as shown in the Contract, will be measured by the number of hours that a pickup broom or equipment capable of collecting sediment, authorized by the Engineer, is used to remove sediment from the roadway or other paved surfaces. Each week the Contractor shall submit to the Engineer a statement detailing the type of sweeping equipment used and the number of hours it was used to pick up sediment. Operator will not be measured and paid for separately but shall be included in the work.

Subsection 208.14 of the Standard Specifications shall be modified as follows:

Payment will be made under:

Pay Item	Pay Unit
Sweeping (Sediment Removal)	Hour

Payment for Sweeping shall be full compensation for all work necessary to complete this item.

1
Revision of Section 208
Erosion Control

Section 208 of the Standard Construction Specifications is hereby removed in its entirety and replaced with the following:

PART I: DEFINITIONS

Definitions used for this Section shall consist of those listed in Title 1 of the City and County of Denver "Standard Specifications for *Construction*, General Contract Conditions", 2011 edition.

Definitions used for this Section hereby incorporate those identified within the City and County of Denver Construction Activities Stormwater Manual (CASM).

Additional Definitions applicable to this Section are listed heretofore:

Basis of Payment: The terms under which "Work" is paid, as a designated "Pay Item" in accordance with the quantity measured and the "Pay Unit."

Best Management Practices (BMPs): Schedules of activities, prohibitions of practices, installation of devices, maintenance procedures, and other management practices deployed to stabilize the construction site to prevent or reduce the pollution of State Waters (see definition below). Stormwater BMPs can be classified as "structural" (i.e., devices installed or constructed on a site) or "non-structural" (procedures, such as modified landscaping practices).

Colorado Department of Health and Environment (CDPHE): State of Colorado, Water Quality Control Division responsible for issuance of State Construction Stormwater Permit.

Construction Activities Stormwater Discharge Permit (CASDP): Permit issued by the City for compliance with City & County of Denver Revised Municipal Code and Department of Department of Transportation & Infrastructure Rules & Regulations concerning the discharge of pollutants in storm generated runoff from construction sites to Municipal Separate Storm Sewer System (MS4, see definition below) or State Waters, via the Municipal Separate Storm Sewer System (MS4).

Construction Activities Stormwater Manual (CASM): City and County of Denver Construction Activities Stormwater Manual (CASM), 2010 edition.

Colorado Department of Transportation (CDOT): State agency that has published standards for Erosion Control with accompanying Erosion Control Supervisor certification courses.

2
Revision of Section 208
Erosion Control

Erosion Control Supervisor (ECS): The Erosion Control Supervisor is assigned by the Contractor to perform duties as described in this Section. The ECS shall be properly trained in BMPs per requirements of Part V below, and shall be under the direction of a Professional Engineer licensed in the State of Colorado when performing any modifications to the Project Stormwater Management Plan (SWMP), as required by CDPHE.

Final Stabilization: Point of construction when all ground surface disturbing activities at the site have been completed and uniform vegetative cover has reached 70% of pre-disturbance vegetative cover, or equivalent permanent features have been employed. At this point, all temporary BMPs can be removed, all construction and equipment maintenance wastes have been disposed of properly; and all elements of the Stormwater Management Plan have been completed.

Major SWMP Modification: Changes to the original SWMP that removes or adds additional area to the Project, or modifies the final hydrology or drainage of the Project.

A Major SWMP Modification requires the submission of revised Stormwater Management Plan (SWMP) elements to the Permit Authority for review and approval. Any adjustments to a SWMP must be performed either by or under the direction of a Professional Engineer licensed in the State of Colorado.

Minor SWMP Modification: Modification to the SWMP that does NOT increase the scope or change hydrology of the Project but: modifies/improves specific BMPs in use at site, indicates progression in phasing of the Project, or specifies relocation of previously approved BMPs within the Project. Any adjustments to a SWMP must be performed either by or under the direction of a Professional Engineer licensed in the State of Colorado.

Municipal Separate Storm Sewer System (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

a) Owned or operated by a State, city, town, county, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of stormwater or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or a designated and approved management agency under Section 208 of the Federal Clean Water Act that discharges to State Waters;
b) Designed or used for collecting or conveying stormwater;
c) Which is not a combined sewer; and
d) Which is not part of a Publicly Owned Treatment Works (POTW).

3
Revision of Section 208
Erosion Control

Permit Authority: The Department authorized by the City to review and process CASDP Applications for Capital and/ or governmental sponsored Projects. The responsible City department serving as the Permit Authority is the Department of Transportation & Infrastructure Project Controls Office. As a clarification, the Development Services Department of the City serves as the point of intake and permit processing center.

Permit Enforcement Authority: The Department authorized by the City to inspect and enforce CASDP Rules and Conditions for all construction Projects within the City's MS4 Boundary. The responsible City department serving as the Permit Enforcement Authority is the Wastewater Management Division of the Department of Department of Transportation & Infrastructure.

State Construction Stormwater Permit: Colorado Revised Statues require that all construction sites/development Projects, which, by definition, disturb one or more acres in area, shall be covered by a State issued general permit for construction activities. Information on the application requirements for the State permit can be obtained by phone at 303-692-3500; or by visiting their offices located at 4300 Cherry Creek Drive South, Denver, CO 80246 – 1530, or on the Web at:
https://www.colorado.gov/pacific/cdphe/news/water-quality-permits

State Waters: Any and all surface waters which are contained in or flow in or through this State, not to include waters in sewage systems, waters in treatment works of disposal systems, waters in potable water distribution systems, and all water withdrawn for use until use and treatment have been completed.

Examples of State Waters include, but are not limited to, perennial streams, intermittent or ephemeral gulches and arroyos, ponds, lakes, reservoirs, irrigation canals or ditches, wetlands, stormwater conveyances (when they discharge to a surface water), and groundwater.

Stormwater Management Plan (SWMP): The Stormwater Management Plan contains the requirements necessary to accomplish all the following:

The SWMP establishes a minimum standard to construct, install, maintain, and remove required BMPs during the life of the Contract to prevent or minimize pollution of stormwater due to erosion, sediment transport, and construction related pollutant generated during all phases of the Project. A SWMP consists of the following elements:

(i) CASDP Narrative Worksheet with Narrative Report. The Narrative Report and supporting documents should fully address the methods to be used to prevent sediment, debris, and other pollutants from entering the MS4 and/ or State

4
Revision of Section 208
Erosion Control

Waters in and around the Project area. Proposed structural and non-structural BMPs should be described with sufficient implementation detail to ensure that the logical phases of the proposed construction Project meet the performance standards listed in the CASM.

(ii) Proposed site drawings and Best Management Practice (BMP) installation details as they apply to the site conforming to the Urban Storm Drainage Criteria Manual, Vol. 3, "Best Management Practices", most current version as issued by the Urban Drainage and Flood Control District (UDFCD), or those established by the City's Department of Department of Transportation & Infrastructure. If erosion control drawings were included within the bid documents for the Project, they shall be used for bid purposes and initial planning/ deployment of BMPs on the Project. If provided drawings are signed/ sealed by a Professional Engineer, they have been pre-approved by the Permit Authority and may be used without revision for purposes of submitting for CASDP. If provided drawings do not have signature/ seal of Professional Engineer licensed by the State of Colorado, they will require revision by the Contractor with Professional Engineer signature/ seal prior to submission to the City and County of Denver for CASDP.

(iii) Supporting documentation related to proposed BMPs that are not currently identified in UDFCD Vol. 3 or as otherwise published by the City.

Any preparation of or adjustments to a SWMP must be performed either by or under the supervision of a Professional Engineer or Landscape Architect, licensed in the State of Colorado. SWMP elements submitted to the City shall also meet currently established criteria of the CDPHE as the SWMP must meet all local, State and Federal requirements.

Substantial Completion of Erosion Control: Point of construction when permanent BMPs have been installed, initial growth is in place, and the site is waiting for vegetative cover to reach 70% of pre-disturbance vegetative cover.

PART II: DESCRIPTION

This Work shall consist of constructing, installing, maintaining, and removing when required, BMPs during the life of the Contract until Final Stabilization to prevent or minimize erosion, sedimentation, and pollution of any waters including storm, drainageways, MS4, State Waters, and/ or wetlands.

Work under this Section includes the Contractor obtaining required Permits, utilizing SWMP elements provided in the Contract, and/ or SWMP elements specifically prepared by the Contractor as defined herein. The work shall also consist of providing on-going maintenance

5
Revision of Section 208
Erosion Control

and monitoring of the SWMP as may be necessary due to the specific and/or dynamic needs of the Project as well as meet all requirements set forth within the CASM.

The Contractor shall coordinate the construction of temporary BMPs with the construction of permanent BMPs to ensure economical, effective, and continuous erosion and sediment control and water pollution prevention throughout the construction period until Final Stabilization is achieved.

When a provision of this Section or an order by the Permit Enforcement Authority requires that an action be immediate or taken immediately, it shall be understood that the Contractor shall at once begin effecting completion of the action and pursue it to completion in a manner acceptable to the Permit Enforcement Authority, and in accordance with applicable Permitting requirements.

PART III: MATERIALS

Materials to be used for BMPs shall conform to each specific detail as set forth within the Project SWMP or as noted on the Contract Drawings.

PART IV: EROSION CONTROL PERMIT STATUS

The current SWMP status for the Project is as follows:

An approved SWMP has been prepared and CASDP obtained by the City prior to bidding of the Project and as such must be properly transferred to the Contractor prior to the start of construction. The SWMP has been provided within the Bid Documents and shall be made a part of the Contract. The Contractor shall coordinate with the Project Manager and Permit Authority to perform the necessary transfer of CASDP from City to Contractor prior to the start of construction. The CASDP transfer form can be obtained at: https://www.denvergov.org/Portals/711/documents/CASDP%20TRANSFER%20FORM.pdf. The Permit transfer will be performed at no cost to the Contractor.
Prior to transfer of CASDP, additional elements shall be completed by the Contractor before the CASDP will be transferred from City to Contractor:

(i) Complete Sections B&E (Permittee & Site Supervisor) of the CASDP “Narrative Report Information Worksheet”.

(ii) Prepare a complete SWMP including any required adjustments for proposed construction phasing, staging areas, or additional items necessary to address applicable project specific Permit requirements. This will require the Contractor to provide or retain a Professional Engineer or subcontract with the original Professional Engineer that prepared the Bid Documents.

6
Revision of Section 208
Erosion Control

(iii) Complete the "Construction Scheduling" section of the "Narrative Report Information Worksheet".
(iv) Include specific methods and/or BMPs that the Contractor will implement to address hazardous spill prevention/ containment response.
(v) Provide any "Additional Documentation and Correspondence" applicable to the Contractor as stated in the CASM. This will require the Contractor to provide or retain a Professional Engineer or subcontract with the original Professional Engineer that prepared the Bid Documents.

If deemed necessary, the Contractor may propose modifications to the approved SWMP once the CASDP has been transferred to the Contractor. Per CASDP requirements, the Contractor shall obtain the endorsement of a Professional Engineer licensed in the State of Colorado for any proposed Major or Minor SWMP Amendments. This may require the Contractor to provide or retain a Professional Engineer or subcontract with the original Professional Engineer of the "For reference only" erosion control drawings.

Per definition, a Major SWMP Modification requires the submission of revised SWMP elements to the Permit Authority for review and approval.

Prior to construction, the Contractor shall obtain the required State Construction Stormwater Permit(s) as applicable. If the City has already obtained the State Construction Stormwater Permit, it shall be transferred to the contractor in the same way as the CASDP. The State Stormwater Permit Transfer form can be obtained at:
https://www.colorado.gov/pacific/sites/default/files/notice%20of%20transfer%20form.pdf

PART V: CONSTRUCTION REQUIREMENTS

A) SCHEDULES:
At least ten (10) working days prior to the beginning of any construction work, the Contractor shall submit for approval a schedule for accomplishment of temporary and permanent BMPs shown in the SWMP. This schedule shall specifically indicate the sequence of clearing and grubbing, earthwork operations, and construction of temporary and permanent BMPs. The schedule shall include BMPs for all areas within the Project boundaries, including but not limited to, haul roads, borrow pits, and storage and other staging sites.

Work shall not be started until the BMP schedule has been approved in writing by the Project Manager, and on-site pre-construction inspection is performed and approved by CCD's NPDES inspector. Once the work has started, and during the active construction period, the Contractor shall update the schedule for all BMPs on a regular basis, and as required to keep the SWMP in compliance.

7
Revision of Section 208
Erosion Control

B) CONSTRUCTION IMPLEMENTATION:
The Contractor shall incorporate into the Project all BMPs that are appropriate for the current phase of work, as outlined in the accepted schedule.

C) UNFORSEEN CONDITIONS:
The Contractor shall direct the ECS (under the supervision of a Professional Engineer licensed in the State of Colorado) to design and implement BMPs for correcting conditions unforeseen during design of the Project, or as possible for emergency situations, which arise during construction. The Project's SWMP, UDFCD Vol 3 standards and details, and CDOTs "Erosion Control and Storm-Water Quality Guide," and any approved modification to these documents as proposed by the Contractor, shall be used as reference documents for the purpose of designing appropriate BMPs. Measures and methods proposed by the Contractor to deal with unforeseen conditions shall be reviewed and approved in writing by the Permit Enforcement Authority and the Project Manager prior to implementation and construction.

In an emergency situation, the Contractor shall use best judgment for immediately responding to the emergency situation as it arises, and shall notify the Permit Enforcement Authority and ECS of the emergency situation and BMPs employed in response as soon as practical after installation.

D) PERMITS:
The Contractor shall obtain all required permits for the Project including those required by federal, state, and local agencies. The Contractor shall obtain (or transfer from the City when specified) required erosion control and water quality permits and shall be responsible for compliance with all requirements under any such permits.

E) EROSION CONTROL SUPERVISOR:
Contractor shall assign to the Project an employee or subcontractor to serve as Erosion Control Supervisor (ECS). The ECS shall be a person other than the Contractor's superintendent, foreman, or equivalent supervisory position. The ECS shall be experienced in aspects of BMP construction and have satisfactorily completed a Colorado DOT or equivalent ECS training program authorized by the City. Proof that this requirement has been met shall be submitted to the Project Manager at least ten working days prior to the beginning of any soil disturbance work. A list of authorized ECS training programs is available from the City upon request.

Additionally, per definition, the ECS shall be under the direction of a Professional Engineer licensed in the State of Colorado when performing any modifications to the Project Stormwater Management Plan (SWMP).

8
Revision of Section 208
Erosion Control

The ECS shall be responsible for oversight of the implementation, maintenance, and revision of the SWMP for the duration of the Project. CCD requires the ECS to fulfill responsibilities as outlined by CDPS such as having financial control and authority to implement BMPs. The ECS's responsibilities shall be as follows:

1) Ensure compliance with all water quality permits or certifications in effect during the construction work.
2) Supervise the installation, construction, and maintenance of all BMPs specified in the Contract and coordinate the construction of BMPs with all other construction operations.
3) Direct the implementation of suitable BMPs as necessary to correct unforeseen conditions or emergency situations. Direct the dismantling of those features when their purpose has been fulfilled due to completion of each Project phase unless the Permit Enforcement Authority agrees that the features be left in place.
4) Attend the preconstruction conference, erosion control preconstruction inspection, Project scheduling meetings, weekly construction/ field meetings, substantial completion and final stabilization inspections, and other meetings regarding construction that could impact water quality.
5) Evaluate all non-stormwater coming onto the site, such as springs, seeps, and landscape irrigation return flow. If such flow is identified, the ECS shall propose appropriate SWMP modifications to the Contractor to protect off-site water from becoming contaminated with sediment or other pollutants.
6) Coordinate with the Contractor to implement necessary actions to reduce anticipated or presently existing water quality or erosion problems resulting from construction activities.
7) Coordinate with the Contractor to ensure all labor, material, and equipment deployed to meet SWMP requirements is judged appropriately.
8) During construction, update and record the following items in the SWMP as changes occur:
    (i) Construction boundaries (may require Major SWMP Modification)
    (ii) Areas of disturbance (may require Major SWMP Modification)
    (iii) Areas used for storage of construction materials, equipment, soils, or wastes.
    (iv) Location of any dedicated asphalt or concrete batch plants.
    (v) Location of construction offices and staging areas.
    (vi) Location of work access routes during construction.
    (vii) Location of borrow and waste.
    (viii) Location of temporary and permanent stabilization

The ECS shall start a new site map before the current one becomes illegible. All site maps shall remain with the SWMP paperwork.

9
Revision of Section 208
Erosion Control

9) Amend the SWMP whenever there are: additions, deletions, or changes in locations of BMPs. SWMP revisions shall be recorded immediately. Items shall be dated and signed at time of occurrence. Specifically, amendments shall include the following:
    (i) A change in design, construction, operation, or maintenance of the site which would require the implementation of new or revised BMPs; or
    (ii) Changes when the SWMP proves to be ineffective in achieving the general objectives of controlling pollutants in stormwater discharges associated with construction activity.
    (iii) Changes when temporary BMPs are no longer necessary from changes in Project phase and are removed. All inspection and maintenance activities or other repairs shall be documented.

All inspection and maintenance activities or other repairs shall be documented. The SWMP and documentation shall be kept on the Project site at all times.

10) Modify the site map with arrows to indicate direction of surface and storm water flowing across the Project site.
11) When adding or revising BMPs in the SWMP, amend the narrative to explain what, when, where, why, and how the BMP is being used, and add a detail to the SWMP.
12) If using existing topography, vegetation, etc. as a BMP, label it as such in the SWMP site map; amend the Narrative to explain when, why, and how the BMP is being used in the SWMP.
13) Record on the SWMP, and implement the approved plan for concrete and asphalt saw cutting, grinding, and milling containment and removal.
14) Update the potential pollutants list in the SWMP throughout construction meeting CASDP requirements.
15) Spills, leaks, or overflows that result in the discharge of pollutants shall be documented on the inspection form. The ECS shall record the time and date, weather conditions, reasons for spill, and how it was remediated. The ECS shall immediately report to the Contractor and Project Manager the following instances of noncompliance:
    (i) Noncompliance which may endanger health or environment.
    (ii) Spills or discharge of hazardous substance or oil which may cause pollution of the City MS4 or State Waters.
    (iii) Discharge of stormwater which may cause an exceedance of a water quality standard.
16) Perform a thorough inspection of the stormwater management system at least every seven (7) days and within twenty-four (24) hours after any precipitation or snowmelt event with the potential to cause surface erosion. If no land disturbing construction activities are present during a storm event, post-storm event inspections shall be

10
Revision of Section 208
Erosion Control

conducted prior to commencing any new land disturbing construction activities, but no later than seventy-two (72) hours following the storm event. The inspection records shall be kept on-site in a written or previously approved format. Inspections shall be conducted during the progress of the work, during work suspensions, or until Final Stabilization of all disturbed areas is approved by Permit Enforcement Authority and shall include the following services at a minimum:

(i) The construction site perimeter, disturbed areas, and areas used for material storage that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. BMPs identified in the SWMP shall be observed to ensure that they are operating correctly.

(ii) The description of potential pollutant sources, and the BMPs identified in the SWMP, shall be revised and modified as appropriate based on the results of the inspection as soon as practicable after such inspection. Modification to the SWMP shall be implemented in a timely manner and in accordance with applicable Permit requirements.

(iii) The operator shall keep a record of inspections. Uncontrolled releases of sediment or polluted storm water or measurable quantities of sediment found off the site shall be recorded with a brief explanation as to the measures taken to prevent future releases as well as any measures taken to clean up the sediment that has left the site. Inspection records shall be made available to the City upon request. Note: documentation of uncontrolled releases at site DOES NOT alleviate any State or Federal requirements for reporting of discharges or upset conditions. Care shall be taken to ensure compliance with all regulatory requirements at site.

(iv) Seven (7) day inspections are required during construction and at all times until Final Stabilization has been achieved. Seeding and mulching of disturbed areas does NOT count as final stabilization until such time as 70% pre-disturbed vegetative cover has been achieved. Sites with growth in place sufficient to deter erosion that have not yet achieved final stabilization may petition the City to grant an alternative inspection schedule while awaiting additional growth for final stabilization. These inspections must be conducted in accordance with the above paragraphs.

F) APPLYING BMPs TO STABILIZE SITE:

The duration of the exposure of incomplete construction to the effects of weather shall be as short as practicable. BMPs such as: seeding, surface roughening, mulching, applying tackifier, use of geotextiles and matting, permanent landscaping, or other selected BMPs shall be applied within fourteen (14) calendar days of completion of grading/soil disturbance activities to stabilize the construction site unless disturbed area is within one-hundred (100) feet of an MS4 or State Waters or has slopes of 3 to 1 or greater in which case BMPs shall be

11
Revision of Section 208
Erosion Control

implemented within seven (7) calendar days of completion of grading activities. Disturbed areas where work is temporarily halted shall be temporarily stabilized within seven (7) days after the activity ceased unless work is to be resumed within thirty (30) calendar days after the activity ceased.

Clearing and grubbing operations shall be scheduled and performed to minimize both the area of the Project disturbed at a given time and the amount of time that disturbed areas remain open. BMPs such as temporary seeding are required between successive construction stages when disturbed areas will not be stable or active for thirty (30) calendar days or more. No payment will be made for additional work required because the Contractor has failed to properly coordinate the BMP schedule, thus causing previously stabilized areas to be disturbed by operations that could have been performed prior to the stabilization. Upon failure of the Contractor to coordinate the permanent BMPs with the grading operations in a manner to effectively control erosion and prevent water pollution, the Permit Enforcement Authority can suspend the Contractor's grading operations and the Project Manager can withhold monies due to the Contractor on current estimates until such time that all aspects of the work are coordinated in an acceptable manner.

G) WORK OUTSIDE LIMITS OF CONSTRUCTION:
Non-contiguous areas outside the limits of construction that are used by the Contractor that include, but are not limited to, borrow pits, haul routes, storage and disposal areas, field offices, maintenance, batching areas, etc., shall have appropriate BMPs implemented by the Contractor at the Contractor's expense. Should said areas meet applicable CASDP Permit criteria, the Contractor shall obtain a separate CASDP or amend existing CASDP for each area as applicable at no additional expense to the City.

H) MAINTENANCE:
The Contractor shall continuously maintain erosion and sediment control BMPs on a daily basis or as directed by the ECS so that they function properly during and after construction (including work suspensions) until Final Stabilization has been approved by the Permit Enforcement Authority. Maintenance includes, but is not limited to, the following items:

(i) From the time seeding and mulching work begins until the date the Project has reached Substantial Completion of Erosion Control, the Contractor shall keep all seeded areas stabilized at all times. Any damage to seeded areas or to mulch materials shall be promptly repaired.
(ii) All inspection sediment removal, and BMP maintenance activities to comply with all Federal, State & Local erosion control permit requirements until Final Stabilization is reached.
(iii) All removal and replacement of existing BMPs due to damage to same suffered either by the Contractor, outside agencies, the public, or acts of God.

12
Revision of Section 208
Erosion Control

(iv) All required mechanical and/ or manual street sweeping.
(v) Discretionary changes required of any regulatory enforcement officer.

If the Contractor fails to maintain the BMPs in accordance with the Contract, or as directed, the City may at the expiration of a period of 48 hours, after having given the Contractor written notice, proceed to maintain BMPs as deemed necessary. The cost thereof will be deducted from any compensation due, or which may become due to the Contractor under this Contract.

I) MINOR SWMP MODIFICATIONS:
Shall be made in the field by the Contractor and thoroughly documented in the Contractor's SWMP narrative and drawings. Should the Permit Enforcement Authority deem minor field modifications inadequate, the Contractor may be required to a) make specific modifications as requested by the Permit Enforcement Authority or b) return to the original approved design specifications. Minor SWMP Modifications are allowed, covered under the original CASDP, and required as part of standard maintenance and operation.

J) MAJOR SWMP MODIFICATION:
The City reserves the right to require changes in the Work or Project Limits that may require a Major Modification to the SWMP and/ or CASDP due to unforeseen circumstances. Should this occur, the Contractor will be responsible for the following (as applicable) and applying for CASDP amendment:

(i) Make required revisions to comply with changing Federal or State rulemaking if it occurs within timeframe of the Project.
(ii) Make required revisions due to unforeseen or unplanned conditions leading to deficient Drawings/ SWMP (hazardous materials encountered, landfills, expansion of work limits, etc.)
(iii) Prepare revised SWMP elements endorsed by a Professional Engineer licensed in the State of Colorado.

K) SUBSTANTIAL COMPLETION OF EROSION CONTROL:
When a CASDP is required for the Project, Substantial Completion of the Project as defined by the City and County of Denver General Contract Conditions cannot be reached until Substantial Completion of Erosion Control has been granted. Granting of Substantial Completion of Erosion Control must be requested by the Contractor and be approved by the Permit Enforcement Authority in the form of a "Certificate of Substantial Completion of Erosion Control".

L) FINAL STABILIZATION: Granting of Final Stabilization must be requested by the Contractor and be approved by the Permit Enforcement Authority. Other permanent soil

13
Revision of Section 208
Erosion Control

stabilization techniques may be proposed, in writing, by the Contractor and used upon approval, in writing, by the Project Manager and Permit Enforcement Authority.

The Contractor shall follow the following procedures for approval of Final Stabilization:

(i) The Contractor shall file an Inactivation Request for Construction Activities Stormwater Discharge Permit (available within CASDP guidance documents) with the Permit Enforcement Authority.

(ii) The Contractor shall coordinate with the Permit Enforcement Authority to hold a Final Inactivation Inspection.

(iii) If passing, the Permit Enforcement Authority transmits a letter of approval for Final Stabilization.

(iv) If not passing, the Permit Enforcement Authority transmits a letter of denial for Final Stabilization with associated inspection report to Contractor.

(v) Stabilization, inspection and maintenance requirements shall continue until confirmation of having met final closure requirements have been granted in writing by the Permit Enforcement Authority.
When Final Stabilization has been reached, the Permit Enforcement Authority shall issue a "Certificate of Final Stabilization".

(vi) Once the Inactivation Request is approved by the City and County of Denver, the contractor can apply to close the State Stormwater Permit.

M) FINAL ACCEPTANCE:
CASDP obligations (including reaching Final Stabilization) may hinder the ability to reach Final Acceptance for the overall Project as defined in the City General Contract Conditions.

PART VI: CONSTRUCTION OF BMPs

BMPs shall be constructed so that they conform to all requirements as set forth within the Project SWMP. They shall meet all requirements set forth within each BMP detail and shall be installed and maintained so that they function in an effective and operable manner.

PART VII: METHOD OF MEASUREMENT

Erosion Control Supervisor (ECS) will be measured by the total number of hours the ECS is required to be on the Project performing the duties (including supervision by a Professional Engineer licensed in the State of Colorado) as outlined in this Specification. The Contractor shall record the tasks that were performed by the ECS and the hours that were required to complete each task. The records for the payment period shall be submitted to the Project Manager after completion of work, at the time of monthly pay request, for approval and acceptance.

14
Revision of Section 208
Erosion Control

Silt fence, silt berms, erosion logs, gravel bags, silt dikes, temporary berms, temporary diversions, temporary drains, and brush barriers will be measured by the actual number of linear feet that are installed and accepted. Stakes, anchors, connections and tie downs used for temporary slope drains will not be measured and paid for separately but shall be included in the work.

Concrete washout structure will be measured by the actual number of structures that are installed and accepted, and if specified on the SWMP as in-ground, will include excavation, embankment, concrete, liner, erosion bales, fencing, and containment and disposal of concrete washout and all other associated waste material.

Storm drain inlet protection will be measured by the unit as specified in the Contract. Sediment trap and sediment basin quantities will be measured by the unit which shall include all excavation and embankment required to construct the item.

Removal and disposal of sediment, concrete & trash that is or is not generated by construction activities will not be measured separately but shall be included in the work.

Any excavation required for the removal of sediment from traps, basins, areas adjacent to silt fences and erosion bales, and any other cleanout excavation of accumulated sediment, and removal of check dams or storm drain inlet protection will not be measured separately but shall be included in the work.

PART VIII: BASIS OF PAYMENT

Work to furnish, install, maintain, replace (if not due to contractor negligence), remove, and dispose of BMPs specified in the Contract will be paid for at the contract unit price.

Payment will be made under:

Pay Item	Pay Unit
Erosion Control Supervisor (includes P.E. oversight)	Hour
Fence (Plastic)	Linear Foot
Concrete Washout Structure	Each
Aggregate Bag	Linear Foot
Vehicle Tracking Pad	Each

15
Revision of Section 208
Erosion Control

Temporary BMPs will be measured and paid for by the BMPs used, except that surface roughening, removal and disposal of sediment, and removal of trash will not be measured and paid for separately but shall be included in the work.

Payment for each BMP item will be full compensation for all work, materials and equipment required to furnish, install, maintain, remove, and dispose of it. BMPs as deployed per the SWMP requiring replacement due to Contractor negligence and or carelessness shall be provided at the Contactor's expense.

Temporary BMPs required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled or for the Contractor's convenience, shall be performed at the Contractor's expense.

If the Contractor fails to complete construction within the approved contract time, payment will not be made for Section 208 pay items for the period of time after expiration of the approved contract time. These items shall be provided at the Contractor's expense.

The cost for any corrective actions required by the State or City due to contractor's failure to obtain or comply with applicable Permits will be borne by the Contractor, including fines and penalties. In the case of failures on the part of the Contractor in controlling erosion, sedimentation, and/ or water pollution, the City may provide the necessary corrective actions. All corrective action costs, including Project engineering costs, will be charged to the Contractor, and appropriate deduction will be made from the Contractor's monthly pay estimate.

The sole remedy for additional costs associated with installation of BMPs as required by regulatory agencies to ensure compliance with Local and State requirements shall be per unit BMP as provided in the Bid Schedule of this Contract. The Contractor however may submit a separate itemized Change Order for any required Major SWMP Modification proposed by the City during the course of the Project.

Pay Units for ECS will be full compensation for the Erosion Control Supervisor including all materials, labor and equipment necessary for the ECS to perform the work. Commute time will not be measured and paid for separately but shall be included in the work. The ECS pay item shall include all labor, Professional Engineering (includes supervisory Professional Engineer licensed in the State of Colorado), and/ or design fees to prepare modifications to Stormwater Management Plan(s), revise or amend Permits, coordinate with State and Local agencies, design special erosion control plans for emergency situations that develop during construction or unexpected weather conditions.

Additional stabilized construction/ staging area proposed by the Contractor beyond the area included in the Bid shall be installed per requirements of the Permit Authority and Permit Enforcement Authority without any additional compensation.

16
Revision of Section 208
Erosion Control

Payment for concrete washout structure, whether constructed or prefabricated, will be full compensation for all work and materials required to install, maintain, and remove the item. This includes, but is not limited to: excavation, embankment, liner, erosion bales, fencing, signing, and containment and disposal of concrete washout and all other associated waste material.

Silt berm spikes and dike staples will not be measured and paid for separately but shall be included in the work.

Payment for storm drain inlet protection will be full compensation for all work, materials, and equipment required to complete the item, including surface preparation, maintenance throughout the Project, and removal upon completion of the work. Aggregate will not be measured and paid for separately but shall be included in the work.

Sweeping, when used as a BMP as shown in the Contract, will be measured by the number of hours that a pickup broom or motorized equipment capable of collecting sediment, authorized by the Project Manager, is used to remove sediment from the roadway or other paved surfaces. Operator will not be measured and paid for separately but shall be included in the work.

Stakes, anchors, connections, geotextile, riprap and tie downs used for temporary slope drains will not be measured and paid for separately but shall be included in the work.

Payment for vehicle tracking pad will be full compensation for all work, materials and equipment required to construct, maintain, and remove the entrance upon completion of the work. Aggregate and geotextile will not be measured and paid for separately but shall be included in the work.

Surveying of permanent BMPs will not be measured and paid for separately but shall be included in the work.

Revision of Section 209
Watering and Dust Palliatives

Section 209 of the Standard Specifications is hereby revised for this project as follows:

Subsection 209.07 paragraph 1 shall be deleted and replaced with the following:

Water for moisture-density control, landscaping, pre-wetting, and for dust palliatives will not be measured and paid for separately but shall be included in the work.

1
Revision of Section 210
Reset Structures

Section 210 of the Standard Specifications is hereby revised as follows:

Subsection 210.01 is hereby revised to include the following:

This work shall also consist of restoring existing landscaping that is disturbed during construction to its original or improved condition. This item applies to all landscaping within the limits of construction. Materials used to restore landscaping shall be replaced "in-kind" unless otherwise approved by the Engineer.

Subsection 210.02 shall include the following:

“Restore Landscaping, In Kind” shall include restoring all landscaping that is disturbed within the limits of construction. This includes landscape concrete and asphalt pavers, landscape rock, flowers, shrubs and landscape timbers. The Contractor shall be required to maintain the landscaping planting in accordance with Section 214.

Subsection 210.09 shall include the following:

Signs and traffic signals shall be reset in accordance with the City and County of Denver Transportation Engineering requirements at locations indicated on the plans. It will be the Contractor's responsibility to supply and install any new materials needed to restore the signs and traffic signals to service at the new location.

Subsection 210.10 shall include the following:

Manholes, pull boxes, water meters and valves shall be adjusted in accordance with the applicable standards of the Utility Owner. The Contractor will be responsible for determining the proper Utility Owner and coordinating these adjustments.

Survey range boxes shall be adjusted as directed by the Engineer.

Reset Inlet Grate will include for each existing single inlet all materials, equipment and labor, to remove and dispose of the existing castings and provide and place new castings with mounting hardware, grout and up to one (1) course of standard brick riser as per Wastewater Standard Details DRWG NO. S-716 and all other labor, equipment, materials and hauling and disposals necessary to complete the work.

Restoration of landscaping beyond limits outlined on the plans and/ or as marked in the field by the Engineer will not be paid for.

2
Revision of Section 210
Reset Structures

Subsection 210.12 shall include the following:

The quantity to be measured where items are reset, adjusted or restored on a "square foot" basis shall be the actual number of square feet of the items completed and accepted.

Subsection 210.13 shall be revised to include the follows:

Pay Item	Pay Unit
Reset Ground Sign	Each
Reset Sign Panel	Each
Reset Pull Box	Each
Reset Fence	Linear Foot
Adjust Valve Box	Each

When the contract does not include pay items for Reset Structures, these items will not be paid for separately but shall be included in the work.

1

Revision of Section 250
Environmental, Health and Safety Management

Section 250 of the Standard Specifications is hereby revised for this project as follows:

Subsection 250.01 shall include the following:

Excavation and drilling activities associated with the proposed project may encounter soil and groundwater that may have been impacted by petroleum products or previous releases of hazardous substances. Workers shall be alert during excavations for any visual or olfactory signs of contamination. If soil and/ or groundwater contamination is encountered, work will stop immediately and the procedures outlined in the project's material management plan and Section 250 of Standard Specifications for Road and Bridge Construction shall be followed. The Contractor shall be responsible for the required workers' health and safety.

If contaminated groundwater is encountered, all groundwater brought to the surface shall not be directly discharged (or allowed to run off) into a storm sewer, wetlands, ditch, or any waters of the State. The water shall be contained in tanks or drums and properly disposed in accordance with all local, state and federal regulations.

Subsection 250.03 shall include the following:

The Contractor shall prepare and follow the material management plan (MMP) to ensure hazardous materials and contaminated groundwater is handled properly. The MMP shall comply with the standard MMP specifications of Denver Department of Transportation & Infrastructure and Denver Environmental Quality.

The Contractor shall be responsible for the required worker health and safety and the public in accordance with all applicable local, state and federal regulations. If contaminated soil and/ or groundwater are encountered, the Contractor's Health and Safety Officer and/ or Monitoring Technician shall be called out to the site to supervise subsurface activities to ensure the safety of workers, as detailed in the CDOT Standard Specification 250 - Environmental, Health and Safety Management and this 250 Standard Specification revision. Denver Environmental Quality will also be contacted.

For proper handling of asbestos-contaminated soil, if any, the Contractor will follow all applicable Solid and Hazardous Waste Regulations and the procedures listed in the project's material management plan (MMP). Asbestos contaminated soil removal must be performed by a Certified Asbestos Inspector (CABI) to determine what, if any, controls must be instituted to allow future activity in the excavation area.

2
Revision of Section 250
Environmental, Health and Safety Management

Subsection 250.09 shall include the following:

All work including monitoring, sampling, handling, material disposal and analytical costs (if necessary) will be paid using Environmental Health and Safety Management (AW).

Subsection 250.10 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Environmental Health and Safety Management	Allowance

Revision of Section 503
Drilled and Vacuumed Caisson

Section 503 of the Standard Specifications is hereby revised for this project as follows:

Section 503.01 is hereby revised to include the following:

This work consisted of constructing the Traffic Signal Pole Foundations using either a drill or vacuum method at the locations as shown on the plans and as directed by the Engineer. The placing of reinforcing steel and concrete in the excavated holes must in accordance with these specifications and in conformity with the lines and grades on the plans or established.

Traffic Signal Pole Foundations shall conform to the requirements of the City and County of Denver's Standard Details for Signal Pole Foundations (Detail 16.1.8).

Section 503.03, delete the first paragraph and replace with the following:

Caisson excavations performed with a vacuum pothole machine will be to prevent drilling through existing utilities. The locations where vacuum method is employed shall be per the approved plans or at the discretion of the Engineer.

Section 503.22 is hereby revised to include the following:

Drilled or Vacuumed Caissons (36 inch to 48 inch) will be measured by the linear foot from the elevation shown on the plans to the bottom of the hole excavated.

Section 503.23 is hereby revised to include the following:

The unit price of drilled or vacuumed caissons (36 inch to 48 inch) shall be full compensation for making all excavations; hauling and disposal of excavated material; performing all necessary pumping; furnishing and placing required concrete and anchor bolts and reinforcement steel, including the reinforcement projecting above the tops of the caissons necessary for splicing; all backfilling; removing casings; and for furnishing all tools, labor, equipment, and incidentals necessary to complete the work. No extra payment will be made for casing left in place.

1

Revision of Section 608
Sidewalks, Curb Ramps and Bikeways

Section 608 of the Standard Specifications is hereby revised for this project as follows:

Subsection 608.01 shall be deleted in its entirety and replaced with the following:

Concrete Sidewalk construction shall conform to the requirements of the City and County of Denver's Standard Details for Curb/Gutter and Sidewalk (Detail 5.2 through 5.4).

Concrete Curb Ramp construction shall conform to the requirements of the City and County of Denver's Standard Details for Curb Ramps (Detail 7.0 through 7.7). Construction of concrete ADA curb ramps to include the installation of detectable warnings.

Concrete Driveway construction shall conform to the requirements of the City and County of Denver's Standard Detail for Standard Commercial Driveway (Detail 6.0 through 6.2).

Subsection 608.02, delete in its entirety and replace as follows:

Materials shall meet the requirements specified in the following subsections:

Joint Fillers 705.01

Concrete for sidewalks, curb ramps, and driveways shall be Class "P", broom finish with natural color as specified in subsections 601.02 and 601.03, except that No. 67 coarse aggregate shall be used.

Concrete for bike lane curb ramps will be colored. The concrete color shall be Davis Color # 860 (Dark Gray).

Detectable warnings shall be the composite dome (Armor-Tile Tactile Systems) for 5' wide curb ramps or the cast-iron dome for the 6' and wider curb ramps. Installation of the detectable warnings on ADA curb ramps shall be in strict accordance with the manufacturer's recommendations.

Alternate materials may be used, if pre-approved by the Engineer. The Contractor shall submit a sample of the product, the name of the selected supplier, and documentation that the product meets all contrast requirements and will be fully compatible with the curb ramp surface to the Engineer for approval prior to the start of work.

Concrete shall be cured with a non-pigmented "clear" curing compound.

All concrete used for sidewalks, curb ramps, and driveways shall be reinforced with polypropylene fibers. Polypropylene fibers shall be FIBERMESH or FORTA FIBRE. Length of

2
Revision of Section 608
Sidewalks, Curb Ramps and Bikeways

fibers shall be as recommended by the manufacturer. Add 1.5 pounds FIRBERMESH or FORTA FIBRE per cubic yard of concrete. The fiber additive utilized in the concrete mix shall be that supplied by the Fibermesh Company, 4019 Industry Drive, Chattanooga, TN, 37416, (800) 635-2308, or approved equal. The Contractor shall submit five (5) copies of fibrous concrete reinforcement product data for use by the Engineer.

Concrete will be subject to inspection and tests as required to assure compliance with quality requirements.

The use of calcium chloride, as permitted under Revision of Section 412, subsection 412.04, is prohibited in colored concrete.

Subsection 608.03(a) shall include the following:

Delete the third sentence and add:

Where excavation to the finished grade elevation results in subgrade of unsuitable soil, the Engineer may designate the unsuitable material to be removed and replaced with approved material. Removal of unsuitable material shall be paid for as Muck Excavation in accordance with Revision of Section 203.05(c), and backfilled with Class 6 Aggregate Base Course, or other material approved by the Engineer.

Subsection 608.03(d) shall be revised to include the following:

Finishing shall occur only after the disappearance of bleed water. The addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted. Sprinkling of pigment onto the fresh surface will not be permitted.

Subsection 608.03(e) shall be revised to include the following:

For Bikeways, control joints shall be zipstrip or sawcut to a minimum depth of ¼ of the total slab thickness and no greater than one-fourth (¼) inch wide. Control joints shall be spaced at 10 feet on center or as noted on the plans. Any damage to the concrete such as spalling, dislodging of aggregate particles, or cracking will be repaired by the Contractor at no additional cost to the Project. If said damage cannot be adequately repaired to the satisfaction of the Engineer, the Contractor shall remove and replace the damaged concrete at no additional cost to the Project.

Subsection 608.03(f) shall be revised to include the following:

3
Revision of Section 608
Sidewalks, Curb Ramps and Bikeways

The Contractor shall insure that new concrete items built under this contract drain properly and, as such, there are no areas of standing water on new concrete items.

The Contractor shall protect all new concrete items built under this Contract against defacement, or other injury, from any cause. If said damage cannot be adequately repaired to the satisfaction of the Engineer, the Contractor shall remove and replace the unacceptable items at Contractor's expense.

Subsection 608.06 shall be revised to include the following:

Payment will be made under:

Pay Item	Pay Unit
Concrete Sidewalk (6 Inch)	Square Yard
Concrete Curb Ramp	Square Yard

Excavation to proposed subgrade elevation will not be paid for separately but shall be included in the work associated with Section 201, Clearing and Grubbing or Section 202, Removal of Structures and Obstructions.

Detectable warnings on new curb ramps, including all labor and materials necessary for fabrication, transport and installation, will not be measured and paid separately but shall be considered included in the work.

It is the Contractor's responsibility to provide Quality Control concrete strength testing and provide test results in a testing frequency, method and report as per Pre-construction submittal approved by the City Project Manager. Quality Control testing, reports and submittals will not be paid for separately but shall be included in the work.

Payment shall be full compensation for labor and materials including, but not limited to prep work, reconditioning, forms, grading, bed course, backfill, curing compound, control and expansion joint and sealant as required to complete these Pay Items.

Excavation to proposed subgrade elevation will not be paid for separately but shall be included in the work associated with Section 202, Removal of Structures, Asphalt Mat and Obstructions.

1
Revision of Section 609
Curb and Gutter

Section 609 of the Standard Specification is hereby revised as follows:

Subsection 609.01 (f) shall be revised to include the following:

Combination Curb, Gutter, and Sidewalk
Variable Height Curb Head
Curb and Gutter, Variable Height Curb Head

Subsection 609.02 shall be revised as follows:

In the first paragraph, reference to Section 703.07, Bed Course Material, shall be deleted.

Paragraph 2 shall be deleted and replaced with the following:

- Concrete shall conform to the requirements for Class "P" concrete as specified in subsections 601.02 and 601.03. When curb machines are used, the Contractor will be permitted to use AASHTO M 43 Size 57 or 67 aggregate in lieu of the coarse aggregate specified in Table 601-1, and a lesser slump will be permitted.

Subsection 609.03(a) shall be revised as follows:

Excavation: Excavation shall conform to the requirements of the Revision of Section 608, Subsection 608.03(a).

Subsection 609.03(c) shall be revised to include the following:

The Contractor shall protect all new concrete items built under this Contract against defacement, or other injury, from any cause. If said damage cannot be adequately repaired to the satisfaction of the Engineer, the Contractor shall remove and replace the unacceptable items at Contractor's expense.

Subsection 609.03(d) shall be revised to include the following:

For construction of curb and gutter adjacent to existing concrete pavement, the joint pattern shall match that of the concrete pavement. The joint pattern shall be approved by the Engineer prior to construction.

Subsection 609.03(i) shall be revised to include the following:

The Contractor shall insure that new concrete items built under this contract drain properly and, as such, there are no areas of standing water on new concrete items.

2
Revision of Section 609
Curb and Gutter

It is the Contractor's responsibility to provide Quality Control concrete strength testing and provide test results in a testing frequency, method and report as per Pre-construction submittal approved by the City Project Manager. Quality Control testing, reports and submittals will not be paid for separately but shall be included in the work.

Subsection 609.07 shall be revised to include the following:

Payment will be made under:

Pay Item	Pay Unit
4" Mountable Curb	Linear Foot
Curb Type 2 (Section B)	Linear Foot
Curb and Gutter Type 2 (Section I-B)	Linear Foot
Curb and Gutter Type 2 (Section II-B)	Linear Foot
Gutter Type 2 (6 Foot)	Linear Foot

Payment shall be full compensation for labor and materials including, but not limited to, reconditioning, grading, backfill, curing compound, control and expansion joint and sealant as required completing these Pay Items.

Excavation to proposed subgrade elevation will not be paid for separately but shall be included in the work associated with Section 202, Removal of Structures, Asphalt Mat and Obstructions.

Revision of Section 610
Median Cover Material (Patterned Concrete)

Section 610 of the Standard Specifications shall be revised for this project as follows:

Subsection 610.02 shall include the following:

All materials in this section shall be submitted to the Project Manager for review as defined in the City and County of Denver Standard Specifications for Construction General Contract Conditions.

Median Cover Material shall be Class B colored concrete and shall conform to Section 601. The integral color for concrete shall be Davis Color “Brick Red”.

Concrete cure shall be as recommended by the supplier of the coloring agent.

All Median Cover Material shall have a UV sealer applied per manufacturer’s specifications and as recommended by the supplier of the coloring agent.

Expansion joint material and sealer shall be installed between the Median Cover Material and the back of curb per the City and County of Denver Transportation Standards and Details.

Joint sealer color shall match median cover material color, to be approved by the Project Manager.

Subsection 610.03 shall include the following:

The Contractor shall place a 4 foot by 4 foot colored concrete test panel for written approval by the Project Manager prior to commencing the work. If the test panel is unacceptable to the Project Manager, the Contractor shall construct additional test panels until the correct color and finish are approved by the Project Manager.

Workmen and equipment used on the test panel shall be the same as used in the final construction of the colored concrete. Physical color samples shall be submitted for approval prior to beginning the test panel.

Subsection 610.03(b) shall be revised to include the following:

Areas to receive median cover shall be treated with herbicide. Treatment shall be applied according to manufacturer’s recommendation.

Median Cover Material shall be installed at minimum of 4 inches or as indicated on the drawings.

Revision of Section 610
Median Cover Material (Patterned Concrete)

Install 8-inch diameter PVC sleeves in the median cover material at signage locations as shown on the approved plans.

Control joints shall be tooled and spaced at 2-foot on center with alternating broom finish pattern as approved by the Project Manager in the test panel. Control joints shall be sealed with the specified joint sealer. All joint-wall surfaces must be clean, free of oils, grease, curing compound residues, and any other foreign matter that might prevent bond.

Expansion joint material (½-inch) shall be installed between the Median Cover Material and the back of curb and sealed with the specified joint sealer. Expansion joints shall also be placed every 100 feet and sealed.

Subsection 610.05 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Median Cover Material (Patterned Concrete)	Square Foot

Payment for Median Cover Material shall include subgrade preparation, herbicide treatment, plastic sheeting and protection, integral coloring, expansion joints, expansion joint material, joint sealer, curing membrane, finishing, sleeves for signs, sawcutting, and all other appurtenant work to complete this item in accordance with the plans and specifications.

Revision of Section 612
Directional Indicator Strip

Section 612 of the Standard Specifications shall be revised for this project as follows:

Subsection 612.01 shall include the following:

This work consists of the installation of Directional Indicator Strips at the locations shown on the plans.

Subsection 612.02 shall include the following:

Directional Indicator Strip shall be Armor-Tile Detectable Directional Tiles and shall include all tiles, adhesives, fasteners, and sealants required. Directional Indicator Strip shall be Federal Yellow in color.

Subsection 612.03 shall include the following:

Directional Indicator Strip shall be installed be Armor-Tile specifications.

Subsection 612.04 shall include the following:

Directional Indicator Strips will be measured by the length of Directional Indicator Strips installed and approved by the Engineer.

Subsection 610.05 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Directional Indicator Strip	Linear Foot

Revision of Section 613
Electrical Conductor Identification

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Subsection 613.08 shall include the following:

All electrical conductors shall be tagged as follows:

Electrical conductor cable tags shall be located below the termination in the base of the streetlight, in the pull box, in the pedestal, and at the point of termination to existing facilities of the Local Utility Company supplying electrical service. The tags shall be attached with a cable tie. The information written on the tag shall include the direction and approximate length of cable, feeds running from where and to, etc.

Each incoming conductor shall be individually color coded with one (1) tape mark, while outgoing conductors shall have two (2) tape marks.

Example:

FEEDS TO PULL BOX 50' NORTH & 75' WEST THEN TO HIGHWAY SIGN	FEEDS FROM XFMR 250' SOUTH & EAST 200' WEST

Uniform tags are available in a Tag Kit. *The Tag Kit consists of: 100 tags, 3-part yellow with 1 hole, 100 black nylon ties and 1 black Sharpie pen.

Manufacturers	Catalog Numbers
Uticom Systems Inc.	U5025Y1 Or approved equal

Subsection 613.14 shall include the following:

Electrical conductor tagging will not be paid for separately but shall be included in the cost of wiring.

1
Revision of Section 613
Electrical Conduit - General

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Add the following to subsection 613.07:

This work is for the installation electrical conduits. These conduits (laterals) shall be connected to the already installed traffic signal conduits to the traffic signal controller cabinets, electric meters, and traffic signal poles. The conduit installation shall be in accordance with this specification:

All conduit bends, including factory-installed bends, shall not have a bend radius less than six times the inside diameter of the conduit.

The excavations required for the installation of conduit or cable shall be performed in such a manner as to avoid unnecessary damage to streets, sidewalks, landscaping, sprinkler systems and other improvements. Trenches shall not be excavated wider than necessary for the installation of the electrical appurtenances. Excavation shall not be performed until immediately before installation of conduits. The material from the excavation shall be placed in a position not to cause damage or obstruction to vehicular or pedestrian traffic or interfere with surface drainage.

Trenches shall be made with a rock-wheel or other machine capable of cutting a narrow trench (4-inches). The machine shall be equipped with shields to direct the spoil downward and away from passing vehicles, workmen and pedestrians. Open trenches shall be covered when pedestrian and bicycle traffic are allowed to cross the trench.

Off-street trenches shall be back-filled with the same material that was removed and shall be compacted and shaped to match the surrounding surface. On-street trenches within ALL roadway areas shall be back-filled with CDOT approved Structure Backfill (Flow-Fill) and capped with 9-inches minimum of Hot Mix Asphalt Pavement (Patching) in accordance with Section 403 and City and County of Denver Street Cut Regulations if applicable. If surrounding pavement depth is greater than 9 inches, the HMA (Patching) depth shall match the existing pavement.

All surface materials including sprinkler systems, landscaping, shrubs, sod grass, and native growth vegetation which is disturbed by trenching and back-filling operation shall be restored in kind equal to or exceeding the original conditions.

All conduit runs that will not have a copper conductor installed shall have a #12 AWG stranded copper conductor placed inside for locating purposes. Locating conductor and tape will not be measured and paid separately but shall be included in the unit price for conduit.

2
Revision of Section 613
Electrical Conduit - General

Conduit shall always enter a pull box, hand-hole, or any other type of structure from the direction of the run only.

All conduits shall be fully compatible with fiber optic cable. Plastic conduit shall be Schedule 80 in the diameters shown on the plans and shall be compliant with Bellcore TW-NWT-000356 requirements. Each conduit shall be equipped with a pull tape and each bore shall have a copper tracer wire of at least 12 gauge.

Plastic PVC conduit shall be certified by the manufacturer as meeting ANSI/UL 6 and 651. The manufacturer shall be ISO 9000 compliant.

All conduit bends, including factory-installed bends, shall not have a bend radius less than six times the inside diameter of the conduit.

Conduit plugs for sealing conduit shall also be supplied and installed in all open conduit ends as soon as the conduit is installed. Plugs shall be durable, fabricated from no metallic parts, be of the split design to allow removal and reinstallation around in-place cables and be easily removable and reusable. Plugs shall be capable of being installed by hand without any tools and shall provide a water and air tight seal of at least one-hundred (100) psi and shall cause no damage to the cable when installed.

At some locations (as illustrated on the Plans or in these specifications, or as directed by the Engineer), new conduits shall be installed in an existing pull box. At these locations, the Contractor shall carefully excavate around the pull box and install the new conduit in the pull box in a manner that meets the requirements of this Special Provision. The Contractor shall not damage the existing pull box. If the existing pull boxes or concrete collars are cracked or damaged during conduit installation, the Contractor shall be required to replace either or both conforming to the requirements of the contract at no additional cost.

Subsection 613.13 shall include the following:

Electrical Conduit will be measured by the linear feet of conduit installed in accordance with these Special Provisions, the Project Standards or as directed by the Engineer. Electrical Conduit will include groundwork, sweeps, pull cord, copper tracer wire, adapters, fittings, splice couplings, conduit plugs (for conduits both with and without fiber optic cable), equipment, labor, and all other items necessary to complete the work.

3

Revision of Section 613
Electrical Conduit - General

Subsection 613.14 shall include the following:

Pay Item	Pay Unit
3 Inch Electrical Conduit (Bored)	Linear Foot
2 Inch Electrical Conduit (Plastic)	Linear Foot
3 Inch Electrical Conduit (Plastic)	Linear Foot

Revision of Section 613
Electric Meter Pedestal Cabinet and Base

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Subsection 613.09 shall include the following:

New traffic signal installations require an Electric Meter Pedestal Cabinet and Base for the new traffic signal. Xcel Energy will furnish only the electric meter. The Contractor shall furnish the electric meter pedestal cabinet, and shall install the pedestal cabinet and base, by a licensed electrician (journeyman), at the locations as show on the plan and in accordance with the City and County of Denver's standard – sheets 16.1.19 and 16.1.20.

Subsection 613.13 shall include the following:

Electric Meter Pedestal Cabinet and Base will be measured and installed in accordance with these Special Provisions, the Project Standards or as directed by the Engineer. The Electric Meter Pedestal Cabinet and Base installation will include groundwork, sweeps, pull cord, copper tracer wire, adapters, fittings, splice couplings, conduit plugs, equipment, labor, and all other items necessary to complete the work.

Contractor shall submit material specifications to the Engineer for prior approval.

Subsection 613.14 shall include the following:

Pay Item	Pay Unit
Electric Meter Pedestal Cabinet and Base	Each

Revision of Section 613
Lighting (Luminaire)

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Subsection 613.02 shall include the following:

The Contractor shall furnish and install LED Street Light Luminaire at locations as shown in the plans. The LED Street Light Luminaire shall be compatible or interchangeable with standard LED Street Light Luminaire as stocked by the City and County of Denver.

The current LED Street Light Luminaire that is compatible with that stocked by the City and County of Denver is as follows:

Manufacturer	Catalog Numbers
E-Lite Star	ESU-CA012M03042S-525CCD1-1

The luminaire shall also include a photo cell (S-T P124-1.5-PTW or equal) and the luminaire finish shall be in Federal Green.

The Contractor shall submit a lighting materials list to the City and Denver for approval prior to ordering. Contact 720-865-4002.

Subsection 613.08 shall include the following:

At least one grounding electrode shall be installed adjacent to each light standard. Wiring shall be a 120/240 volt or 120/208 volt, 3-wire system with individual luminaire wired for 120 volts.

Subsection 613.14 shall include the following:

Pay Item	Pay Unit
Luminaire (LED)	Each

Luminaire shall be measured and paid by the number of luminaire installed. The item shall include all labor, materials, and ancillary hardware required to provide a fully-functional system to the satisfaction of the Engineer.

Revision of Section 613
Pull Boxes – General

Section 613 of the Standard Specifications is hereby revised for this project as follows:

Subsection 613.07 shall include the following:

Traffic signal pull box shall be the type B pull box. The covers of the type B pull box shall have the word “TRAFFIC” physically impressed (not painted) on top. Communication pull boxes shall be the type C (24x36x24) pull box. The covers of the type C pull box shall have the words “TRAFFIC COMM” physically impressed (not painted) on top. The covers shall be attached to the pull box body by screw-in bolts and shall have two lift slots to aid in the removal of the lid.

All concrete collars, footings, and location marker supports shall be Portland Cement Concrete Class B and shall be in accordance with Section 601.

Pull boxes that are to be in traveled ways shall be outfitted with traffic bearing lids rated for HS 20- 44 loads. The pull boxes shall have a special concrete footing extending eight (8) inches around the outside and six (6) inches around the inside of the pull box bottom, as shown in the plans. Pull boxes installed in dirt or landscape areas shall have a twelve (12) inch wide by six (6) inch thick concrete collar placed around the top in lieu of the concrete footing, as shown in the plans.

When the plans call for a fiber optic cable location marker to be installed at the pull box location, the concrete foundation support for the location marker shall be placed monolithically with the concrete collar.

Subsection 613.14 shall include the following:

Pay Item	Pay Unit
Type B Pull Box	Each
Type C Pull Box	Each

Type B and Type C pull boxes shall include the removal of any existing pull boxes, installation of the new pull boxes, modification of conduit ends, restoration of disturbed surface materials, and all other work necessary to complete the installation. All work necessary for the removal and installation of pull boxes will not be measured and paid for separately but shall be included in the cost the work.

Type B and Type C pull boxes will be paid for on the basis of the number of pull boxes installed. All other pull boxes required to complete the work will not be measured and paid separately but shall be included in the work of the conduit installation.

Revision of Section 614
LED Pedestrian Signal Face (16) (Countdown)

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work includes the installation of LED Pedestrian Signal Faces with countdown timers as shown in the plans.

Subsection 614.08 (i) shall include the following:

Pedestrian signal faces with count down timers shall meet the following requirements:

i. The dimensions of the signal housing and the LED symbols, as well as moisture and dust resistance requirements shall be in accordance with the current ITE PTCSI Standards.
ii. Signal housing shall be aluminum, painted in Federal Green and “clam-shell” mounted.
iii. The signal shall have user-selectable modes for countdown for walk cycle only, pedestrian cycle only, or both walk and pedestrian clearance.
iv. The countdown module shall have an internal conflict monitor to prevent any possible conflicts between the Hand/ Person signal indications and the time display. The display shall not countdown during a Solid Hand indication.
v. LED symbols shall be solid icons and shall provide uniform light dispersion such that the “pixel” effect is minimized. Lettered or outline symbol styles will not be permitted.
vi. The Man/Hand configuration shall provide clear and distinct lamination where either symbol is in use.
vii. The LED module shall be rated for use in an ambient operating temperature range of -40° F to 165° F.
viii. The signal shall meet NEMA Standard TS2 for voltage surge protection, and shall have an automatic reset in case of a power outage.

Subsection 614.13 shall include the following:

LED Pedestrian Signal Face (16) (Countdown) will be measured by the actual number of units that are installed and accepted.

Subsection 614.14 shall include the following:

Pay Item	Pay Unit
Pedestrian Signal Face (16) (Countdown)	Each

1

Revision of Section 614
Traffic Control Devices

Section 614 of the Standard Specification is hereby revised as follows:

Subsection 614.08 (i) shall include the following:

"Light Emitting Diode" (LED) signal lenses shall be installed in all Red, Yellow, Green, signal displays. The LED signal lenses for the 12-inches, circular balls, 12-inch circular arrows, and 12-inch and 8-inch circular bicycles are hereby added to the Standard Specifications and shall comply with the following specifications:

Manufacturer Requirements and Approvals:

- The manufacturer supplying product to this specification shall have a minimum of 13 years of experience in the manufacture of LED Traffic Signals with High Flux LEDs used in the North American market.
- Manufacturers supplying products to this specification must be a registered participant and have the unique long life module part numbers being provided certified and listed on the Intertek-ETL LED Traffic Signal Modules Certification Program approved products website prior to bid opening.
- Manufacturers supplying products to this specification shall manufacture and assemble product on an Intertek ETL audited line located in the USA.
- Unique part number shall be listed on manufacturers label proving difference between standard modules and long life modules.
- If requested, documentation shall be provided by manufacturer demonstrating the changes made to their standard product that allows for ITE specification compliance over 15 year warranty period.

Physical & Mechanical Requirements:
General

- Tinted or Non-Tinted Lens. Unless designated otherwise in the below table the standard lens color shall be tinted with a color meeting the colors required in paragraph 4.2 of the ITE specification. The products shall be available with non-tinted lenses as an option.
- The LED module shall utilize high flux LEDs rated at 1 watt or higher and have an incandescent, non-pixilated appearance when illuminated. The use of low power LEDs, for example 5 mm LEDs, is not permissible in the design and production of long life arrow products.
- The external lens shall have a smooth outer surface to prevent the build up of dirt/dust and shall be designed to minimize the potential for sun phantom signals.
- All LEDs utilized to illuminate circular signal modules, shall be LEDs that have been manufactured utilizing materials that have industry acceptance as being suitable for uses in outdoor applications. At no time is the use of LEDs that utilize AlGaAs technology acceptable.

2
Revision of Section 614
Traffic Control Devices

- The thermal management system used in the traffic ball must be self- contained and internal to the traffic module. At no time shall the thermal management system used for the power supply or LEDs form any part of the external surface of the LED module.
- All plastic components shall be molded and assembled in the USA. This includes: back housing, spreading lens and front lens. Certificate of manufacturing location must be available and supplied at time of bid requested.
- All lenses shall be hard coated in the USA. Certificate of manufacturing location must be available and supplied at time of bid requested. All reflectors shall be metalized in the USA. Certificate of manufacturing location must be available and supplied at time of bid requested.

Module Identification

- In addition to the required ITE labeling all modules must be labeled with the ETL Verified label shown in Figure 1. This label designates the compliance and listing with the Intertek-ETL Traffic Signal Certification Program.

Electrical: General

- The following color scheme shall be used for all modules AC power leads: White for Common, Red for the Red ball signal, Yellow for the Yellow ball signal, and Brown for the Green ball signal.
- The AC power leads shall exit the module via a rubber grommetted strain relief, and shall be terminated with insulated female quick connect terminals with spade/tab adapters. The leads shall be separate at the point at which they leave the module.
- All external wiring utilized in the LED traffic signal module shall be anti-capillary type wire to prevent the wicking of moisture to the interior of the module.
- LED Module and power supply shall be design to remain ITE compliant over a 15 year life.
- To minimize the temperature exposure of the power supply all power supplies should be located at the bottom of the module when the arrow is facing left.
- For additional protection from moisture, all power supplies shall be conformal coated for additional protection.

Transient Voltage Protection

- In addition to the transient test requirements defined in the Design Qualification Testing section of ITE Vehicle Traffic Control Signal Heads (VTCSH) specification all power supplies used in the circular signals supplied to this specification shall be capable of passing an additional ring-wave surge testing in accordance with the IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits, ANSI/IEEE C62.41.2-2002, 6KV, 100 kHz ring-wave

3
Revision of Section 614
Traffic Control Devices

with an output impedance of 30 ohms. The short circuit current shall be 200 Amps.

Power

- Typical wattages at 25 o C for the 12-inch circular arrow LED traffic Signal Modules shall be: Red - 8 watts, Yellow - 13 watts, and Green - 8 watts.
- Typical wattages at 25o C for the 12-inch circular ball LED traffic Signal Modules shall be: Red - 7 watts, Yellow - 11 watts, and Green - 7 watts. Typical wattages at 25o C for the 8-inch circular ball LED traffic Signal Modules shall not exceed: Red - 8 watts, Yellow - 10 watts, and Green - 8 watts.

Quality Assurance General

- Upon Request, the supplier must provide an Intertek-ETL test report for the base model being supplied to this specification.
- The base products must be listed in the Intertek Directory of LED Traffic Signal Modules Certified Products listing at the time of bid. Upon request the supplier must provide a copy of the listing in the bid package.

Warranty Requirements:
Warranty

- Manufacturers shall provide a detailed written warranty issued by the factory of module origin with the following minimum provisions:
- Modules shall, at the manufacturer's option, be repaired or replaced if the module fails to function as intended due to workmanship or material defects within the first 15 years from the date of delivery.
- Modules shall, at the manufacturer's option, be repaired or replaced if the module exhibit luminous intensities less than the minimum specified values within the first 15 years of the date of delivery.
- Upon request, the LED lamp module manufacturer shall provide written documentation of its ability to satisfy a worst-case, catastrophic warranty claim.
- A current corporate annual report duly-certified by an independent auditing firm, containing financial statements illustrating sufficient cash-on-hand and net worth to satisfy a worst-case, catastrophic warranty claim is an example of suitable documentation.
- The documentation shall clearly disclose:
    - The country in which the factory of module origin is located
    - The name of the company or organization that owns the factory of module origin including any and all of its parent companies and/ or organizations, and their respective country of corporate citizenship
- For firms with business and/ or corporate citizenship in the United States of less than fifteen years, the process by which the end-users/owners of the modules will

4
Revision of Section 614
Traffic Control Devices

be able to obtain worst-case, catastrophic warranty service in the event of bankruptcy or cessation-of-operations by the firm supplying the modules within North America, or in the event of bankruptcy or cessation-of-operations by the owner of the factory of origin, shall be clearly disclosed.

Backplates:
Backplates shall be provided with boarder tape around the outer perimeter of the backplate. The tape shall be a minimum 1.5 inches wide, diamond grade DG3 reflective sheeting, fluorescent yellow 4081 or approved equal.

Subsection 614.14 shall include the following:

LED signal lenses and backplates shall be included in the cost of the item for Traffic Signal Face and will not be paid for separately.

Revision of Section 614
Traffic Signal Backplate

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.08(j) shall include the following:

Traffic signals that are mounted on the mast arm shall include a non-louvered type "Traffic signal backplate." The backplate shall include a fluorescent yellow border tape that meets ASTM D4956 Type XI reflective sheeting or approved equal, and shall be of the following:

- 1.5 Inch wide
- Diamond grade DG3 Reflective sheeting
- Florescent Yellow 4081

Traffic signals mounted on the mast arm of a HAWK (pedestrian hybrid) signal, shall not have backplates installed.

Subsection 614.13 shall include the following:

Traffic signal backplates will not be measured and paid for separately but shall be included in the cost of the items for Traffic Signal Face.

1
Revision of Section 614
Accessible Pedestrian Signal

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

Subsection 614.01 shall include the following:

This work consists of the construction of an accessible pedestrian signal system at locations as shown on the plans.

Delete subsection 614.08 (f) and replace with the following:

The Accessible Pedestrian Signal (APS) shall be an audible-tactile pedestrian signal system and shall consist of all electronic control equipment, mounting hardware, push buttons and signs designed to provide both a pushbutton with a raised, vibrating tactile arrow on the button as well as a variety of audible indications for differing pedestrian signal functions.

The APS shall meet the following requirements:

(a) 2009 Manual of Uniform Traffic Control Devices (MUTCD), Chapter 4E – Pedestrian Control Features.

(b) NEMA TS 2 Section 2.1 requirements for Temperature and Humidity, Transient Voltage Protection and Mechanical Shock and Vibration.

(c) IEC 61000-4-4; 4-5 Transient Suppression requirements.

(d) FCC Title 47, Part 15, Class A, Electronic Noise requirements.

The APS pushbutton enclosure shall meet the NEMA 250 – Type 4X enclosure requirement. As specified on the plans, all APS shall receive power and control data from a single Central Control Unit (CCU) in the traffic signal cabinet.

Upon installation the APS shall meet the following functional requirements:

(a) APS functional requirements. The APS shall have the following functional features:

1. The APS shall be programmable and adjustable. Programming and adjustments shall be made using a laptop computer or vendor supplied hand held infrared device with password security. Infrared device shall be capable of setting/updating all push button stations on the intersection from a single push button station (global updating). No additional hardware or equipment shall be required. The APS shall be fully compatible with the three latest versions of the Windows operating platform. The programmable features shall be:

2

Revision of Section 614
Accessible Pedestrian Signal

A. Push-button locator tone. The system shall have, at a minimum, three programmable locator tones.

B. Walk and Wait audible message. The system shall have five (5) Walk Sound Choices (Field Selectable) and three (3) Ped-Clearance Sound Choices (Field Selectable).

C. Audible crossing beacon. System shall be able to mute sounds on all crosswalks except activated crosswalk (selectable feature).

D. Vibrating tactile arrow. The arrow/button shall vibrate during the WALK period, following a button push.

E. Independent minimum and maximum volume limits for the Locator Tone, Walk and Audible Beacon features.

F. Extended Push Activation

(1) Extended Push Activation shall have the ability to extend the WALK time and provide an audible Direction of Travel message. Activation shall be programmable from one to six seconds. A customized Information Message shall be an optional feature with Extended Push Activation.

2. All audible features shall emanate from the pedestrian pushbutton housing. The APS shall utilize digital audio technology, having a minimum 12-bit sample at a 16k Hz sample rate. Total harmonic distortion shall be less than 3 percent at 75 decibels. The APS shall provide independent ambient sound adjustment for the Locator Tone feature. The APS shall allow for Locator Tone volume to be set below the ambient noise level. All sound levels shall adjust automatically utilizing an internally mounted, interval ambient sensing microphone, in accordance with the MUTCD.

3. The APS shall monitor the WALK condition for conflict operation. As a standalone unit, the APS shall disable the Walk functionality should a conflict be detected.

4. The APS system shall log cumulative call data. The data shall be date and time stamped, and shall be accessible via laptop.

5. The system shall provide a programmable audible Wait message when the button is pushed. The message shall only annunciate once per actuation.

6. All Sounds for all push button stations shall be synchronized.

7. System shall have multiple language capability (selectable feature)

3
Revision of Section 614
Accessible Pedestrian Signal

8. System shall be able to play emergency preemption message

(b) Central Control Unit (CCU):

1. The CCU shall power at least 16 APS.
2. The CCU shall control at least 16 APS.
3. The CCU shall be logically configurable to assign any APS to one of 16 traffic phases.
4. The CCU shall receive pedestrian phase WALK, DONT WALK and Clearance inputs from an SDLC input.
5. The CCU shall be able to self-test all APS and put a corresponding phase into recall should an APS assigned to a phase fail the self-test.
6. The CCU shall provide optically isolated general purpose inputs.
7. The CCU shall be used with a 4-cable interface harness assembly.
8. The CCU shall have internal storage to log several hundred events with a date-time stamp for each event.
9. The CCU shall have an internal real-time clock capable of setting in the field and propagating the time to each connected APS.
10. The CCU firmware shall be updatable via either Wi-Fi or Ethernet. There shall be not requirement for the IC chips or module hardware to be removed or exchanged in order to complete the firmware update.
11. The CCU shall monitor PED interval conflicts and switch affected APS to an OFF state when a conflict occurs.
12. The CCU shall meet NEMA 250 – Type 1 enclosures requirements.
13. The CCU shall have a backlit LCD screen and button interface to allow placing test calls and display status.
14. The CCU shall provide remote user access to cumulative call data logs via Ethernet connection.

(c) Push Button Assembly (PBA):

1. The PBA shall be a single assembly containing an ADA compliant, vibro-tactile, directional arrow button, weatherproof audible speaker and informational sign with optional placard braille messages. The PBA housing shall not incorporate any plastic or polycarbonate parts.
2. The PBA tactile arrow shall be 2 inches in length and shall be field

4
Revision of Section 614
Accessible Pedestrian Signal

adjustable to one of four directions.

3. The pushbutton shall utilize Piezo switch technology rated at greater than twenty million operations. Vibro-tactile operation shall pulse at 20 Hz with a minimum 0.003-inch displacement against a 2-pound applied force.
4. The PBA assembly shall be capable of mounting on a curved or flat surface utilizing either machine screws or bolts or banding type mounting hardware. The PBA shall accommodate mounting to a minimum 2-inch diameter pole.
5. Push Button Frame Adaptor and MUTCD Supplemental shall include standard plaque R10-3(e) (9 inchesX15 inches).
6. Push button station frame shall be made of cast aluminum with mounting holes to hold a 9 inchesx15 inches Pedestrian Sign.
7. Pedestrian Button Casting(s) shall be yellow.

Subsection 614.10 shall include the following:

The Contractor shall install the APS and CCU in accordance with manufacturer's recommendations.

The Contractor shall install the CCU inside the Traffic Signal Cabinet, to be powered by the AC supply mains (115 VAC).

Subsection 614.13 shall include the following:

The Accessible Pedestrian Signal units will be measured as the actual number that are installed and accepted. When multiple buttons are on the same pole, each button will be measured separately.

Subsection 614.14 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Accessible Pedestrian Signal	Each

Payment will be full compensation for all work, materials and equipment required to install a fully operational APS in accordance with these specifications.

5

Revision of Section 614
Accessible Pedestrian Signal

Payment for Accessible Pedestrian Signals shall be full compensation for all work, materials and equipment required to install one Accessible Pedestrian Signal.

1

Revision of Section 614
Traffic Signal Controller and Cabinet

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work shall consist of furnishing, assembling, programming, and installing a completed Traffic Signal Controller Cabinet assembly. The Cabinet assembly shall be assembled in accordance with the City and County of Standards and Specifications, and the completed Traffic Signal Controller Cabinet shall include but not limited to the traffic signal controller, malfunction management unit (MMU), vehicle detector amplifiers, other ancillary hardware, and traffic signal cabinet base as per City and County of Denver standards. The Contractor shall install the completed Traffic Signal Controller Cabinet assembly at the locations as shown in the plans.

Delete Subsection 614.08 (b), and replace with the following:

1.1 Applicable Standards

All electronic components, workmanship, and functionality of the traffic signal controller shall conform to the applicable standards for TS-2 traffic signal controllers mandated by the National Electrical Manufacturers Association's (NEMA) current edition NEMA Standards Publication TS2-2003 v02.06 for Traffic Controller Assemblies with National Transportation Communications for ITS Protocol (NTCIP) Requirements. Controller engine board and operating system shall support open architecture and be compliant with current ITE, AASHTO, and NEMA Standard Publication for Advanced Transportation Controllers (ATC) 5201.

All major components shall meet the environmental, design, and operating standards outlined in NEMA Standards Publication TS2-2003 v02.06, Section 2.

These standards specify minimum requirements for the traffic signal controller except where requirements specified in this document exceed the aforementioned documents.

1.2 Hardware

1.2.1 Enclosure

The Controller enclosure shall be designed for placement on a shelf. The enclosure shall be aluminum with a protective finish and enclose all electrical components of the controller. The enclosure size shall be equal to or less than the following: TS-2 Type 1 Controller: 8.5" Tall x 8.5" Deep x 14 ¾" Wide; TS-2 Type 2 Controller: 10 3/8" Tall x 8.5" Deep x 14 ¾" Wide. All hardware and electrical components shall be modular for

2
Revision of Section 614
Traffic Signal Controller and Cabinet

ease of replacement and repair. All controller input/output connectors, fuse holders, indications, displays, switches and control devices required for the operation and adjustments of the controller shall be mounted on the front panel. The front panel of the controller shall be permanently marked to identify I/O connections, fuse holders, indicators, etc.

1.2.2 Additional Hardware Requirements

- Power supply must be capable of supplying 95-250 VAC 50/60HZ Auto Sensing
- Engine Board and CPU shall be compliant with the ATC 5201 Standard as noted above and shall meet the following additional specifications:
    - Minimum Processor: Motorola PowerPC (Freescale) 8248 Processor;
        - 32-bit
        - 750 MIPs at 400 MHz
    - Minimum Required Memory
        - 1 MB SRAM
        - 64 MB SDRAM
        - 64 MB DRAM
    - On-board 5-Pin USB Motherboard Connector
- There shall be no batteries or moving parts such as fans or memory storage devices with rotating parts on the controller unit
- Display shall be a 16-line x 40-character LCD
- All keypads to be mounted on the controller front panel and are to be weather resistant and backlit
- Controller hardware shall facilitate the use of the controller in TS-2 Type 1 traffic signal control cabinets.

1.2.3 Communications Ports

In addition to the NEMA TS-2 with NTCIP v02.06 Standard, the traffic signal controller shall include the following communications ports and configurations:

- Ethernet Support:
    - Side mounted, four-port 10/100 Mbit Ethernet network switch
    - Front panel mounted four-port 10/100 Mbit Ethernet network switch
    - Integrated network card supporting two independent, user programmable subnets (IP Address, Subnet Mask, and Default Gateway)
- USB Support
    - Front Mounted three-port Universal Serial Bus (USB) Hub
    - Side Mounted single USB port

1.3 Operating System

3
Revision of Section 614
Traffic Signal Controller and Cabinet

1.3.1 O/S Version

The Traffic Signal Controller shall use a Linux operating system (O/S) with kernel version 3.14 or later and shall include standard POSIX libraries for application support including real-time extensions of POSIX 1003.1b. To facilitate application level access to the ATC hardware, a Board Support Package (BSP) shall be provided by the controller manufacturer for access to hardware-specific drivers.

The operating system shall include enabled support for cgroups (control groups) for the purpose of limiting, accounting for, and isolating resource usage (CPU, Memory, etc.) of all running processes to ensure the reliability and stability of the traffic signal control application.

The Linux operating system shall include an application programming interface in compliance with the ITE, AASHTO, and NEMA Application Programming Interface (API) Standard 5401 for the ATC v2.0.

1.3.2 O/S Updates

Operating System updates shall be completed from a personal computer over an Ethernet connection and also directly from a USB flash drive plugged into the controller's front panel. The update process shall be automated and packaged as a simple executable file enabling the user to perform the update within a few steps. Minor operating system updates shall allow the user to perform the operating system update without removing the controller from operation or without placing the intersection in flash. The controller shall also allow for all traffic signal controller software updates through the Application Programming Interface without removing the controller from operation or without placing the intersection in flash.

1.4 Intersection Control Software

The intersection control software should provide at a minimum, the functionality and operations specified in the NEMA TS-2 with NTCIP v02.06 Standard. All objects and functions available in the local control software should be named and defined according to the current NTCIP standard. Additional, non-required or manufacturer specific objects and functions should have a straight-forward, logical label and/ or definition.

1.4.1 Basic Functionality

4
Revision of Section 614
Traffic Signal Controller and Cabinet

In addition to the aforementioned NEMA TS-2 Standard, the controller must satisfy the following additional requirements:

- 40 programmable phases
- 16 timing rings that can be configured by the user to run concurrently or independently
- 32 overlaps
- 20 unique phase sequences that can be programmed and operated by time of day. Each sequence should allow the user to specify specific phase order and sequence beyond basic phase pair reversal/switching
- 128 unique timing patterns, each with a unique:
    - Cycle length, free, or flash command
    - Phase split table
    - Offset
    - Phase or pedestrian recall or omit (per pattern)
- User can easily configure:
    - Flashing Yellow Arrow functionality
    - Pedestrian Overlaps
    - Pedestrian advance or exclusive pedestrian intervals
    - Trailing green sequences for compound intersections
    - Preemption routines in accordance with the NEMA TS-2 specification (v02.06)
    - HAWK Signals
- Detectors
    - 10 detector tables selectable by TOD
    - 72 detectors per detector table
    - Ability to call multiple phases with one detector
    - Ability to call overlaps directly
    - Detector Diagnostics
- 16 Preempt Routines
    - Return to Coord without transition
    - Return to the longest waiting phase
    - Return to the last phase skipped in sequence
- 10 Overlap tables selectable by TOD
- Transit Priority functionality
- Peer to Peer communications
    - Allows for direct messaging between two controllers
    - Allows user to send the status of ANY input/output function in the controller as well as phase intervals, preempt intervals, etc.
- 32 Customizable Alarms

1.4.2 User Interface

5
Revision of Section 614
Traffic Signal Controller and Cabinet

In addition to the front panel screen, the traffic signal controller shall have an on-board web server which hosts a graphical user interface for monitoring and configuring the intersection control software. The web server interface shall provide access from any internet enabled device with a web browser. No additional or proprietary software shall be needed to use the graphical user interface. The user interface shall include the following features and functionality:

- User Access Control: Local software shall allow for configuration of user groups to limit read/write permissions of individual controller programming and status menus to a set of users; permissions and user accounts shall be synced to all network connected controllers via included central-based profile server,
- Real-Time Signal Performance Analytics: The local controller web-server shall support graphical signal performance analytic tools such as a split monitor, a cycle length plot, phase termination diagrams, coordination diagrams, etc., without the need of a central signal system,
- On-Board Replay: Controller shall include a graphical based, on-board utility to replay recent operation to troubleshoot a failures. At a minimum, replay shall include ring timers, phase and overlap states, detector calls, channel status, etc. for the previous 3 minutes of operation,
- Change Tracking: Front panel or web-UI entered database changes shall be logged with the time/date stamp and username.

1.4.3 Input/output Configuration

The intersection control software should allow the user to dynamically configure and modify input and output pins on an individual, pin by pin basis. In addition, the user should be able to configure the signal output channels (phase/overlap to load-switch) so that any phase, overlap, or pedestrian output can drive any available load-switch in the traffic signal cabinet. The user shall perform such configurations and modifications from the controller front panel and also through the web user interface, without the need for additional configuration software or downloading additional files to the controller.

1.4.4 Master and Peer-to-Peer Communications

The signal controller shall be capable of operating in a closed loop network with other controllers as a master or slave controller without the need for additional software or licensing. The master unit must be able to perform the duties of a master controller in the closed loop network while simultaneously conducting traffic signal operations at the local intersection. The signal controllers within the network will communicate with other controllers via serial or Ethernet communications.

6
Revision of Section 614
Traffic Signal Controller and Cabinet

The Intersection Control Software shall support Peer-to-Peer functionality. Peer-to-Peer allows the controllers to send messages to other controllers connected in the same network via Ethernet communications.

1.4.5 Advanced User Programs (User Logic)

In addition to standard operations specified in the NEMA TS-2 for NTCIP v02.06 Standard, the intersection control software shall have a logic processor where the user can develop advanced logic statements and operations to be used as custom solutions or for feature development. In addition to standard Boolean logic, the user shall be able to specify conditions using all input and output functions including but not limited to phase indications and intervals, detector calls, preempt status, interval/service times, and greater than/less than relationships. For example, the processor shall provide a way for the user to program the following condition in the controller front panel: “Call preempt 5 if phase 2 is green for more than 25 seconds. Also send a message to the downstream controller to start preempt 2 in 15 seconds if the coordinator is currently in transition.”

1.4.6 Database Management

The intersection control software and traffic signal controller shall be capable of storing multiple traffic signal databases (timing files) on the controller at any given time. The software should allow the user to save to or select from the list of stored databases on the controller from the front panel or web user interfaces. Databases shall be transferred between a personal computer and the traffic controller via an Ethernet connection using the web-user interface or using a standard FAT (or FAT-32) formatted USB flash drive using the controller front panel user interface. The software shall provide a user interface to select and save a database from the USB flash drive to the controller when multiple databases are located on the USB flash drive. The controller shall be able to switch between the current and stored databases at any time. The controller will set the selected database as “Active” at the end of the current sequence during an all-red condition timing less than 4 seconds.

1.4.7 Windows Based Controller Emulation Software

In addition to the above, one copy of a Windows based traffic signal controller emulation software package shall be supplied. This program would allow the user to program a traffic signal controller on a Windows based computer and shall be compatible with the latest version of the Windows operating system. The program supplied shall be the same version as the firmware version supplied with the controller. This program would allow the user to program a complete traffic signal controller and can be saved on a USB

7
Revision of Section 614
Traffic Signal Controller and Cabinet

memory drive for transfer to a controller. This program shall be updated and supplied to the City at the same time as the Linux firmware for the controller and shall be supplied no charge for any updates.

1.4.7 Connected Vehicle Ready

Controller shall be CV Ready: "Time to Green" and associated confidence intervals must be supported via standard or manufacturer specific NTCIP objects and over XML protocol and included in manufacturer's NTCIP MIBs.

Delete Subsection 614.08 (c) and replace with the following:

All new cabinets shall be the latest P-type cabinets as per the City & County of Denver Traffic Signal Standards. Each cabinet shall be installed on a newly installed traffic signal controller cabinet base unless otherwise specified on the plan.

Controller cabinet assemblies shall include an integrated uninterrupted power supply (UPS) units, and an Ethernet Field Switch that comply with the City and County of Denver standards (see UPS and Ethernet Field Switch specifications).

The Controller Cabinet shall also include a malfunction management unit (MMU) that meets the following requirements:

- NEMA Standard TS2-2016 for MMU2 configuration will maintaining compatibility with the NEMA TS1-1989 assemblies.
- Flashing Yellow Arrow PPLT operation and meets / exceeds the NEMA Standard MMU2 requirements of TS2-2016 FYA, providing modes for both TS-2 or TS-1 cabinet configurations.
- Real-time SDLC communications with the Controller Unit exchanges field input status, Controller Unit output status, fault status, MMU programming, and time and date.
- A time-stamped nonvolatile event log records the complete intersection status as well as AC Line events, configuration changes, monitor resets, temperature and true RMS voltages.
- A Sequence History log stored in nonvolatile memory graphically display up to 30 seconds of signal status prior to each fault event.
- View the intersection signal status remotely with manufacturer provided software via the MMU Ethernet port.

Subsection 614.09 shall include the following:

8
Revision of Section 614
Traffic Signal Controller and Cabinet

The Contractor shall assemble the traffic signal controller, cabinet, and other auxiliary hardware in accordance with the City and County of Denver Department of Transportation & Infrastructure – Transportation Operations criteria, and program the traffic signal controller per the approved traffic signal timing work order. All traffic signal timing (controller programming) shall be bench tested with a minimum of 72-hours burn time to verify successful operation prior to installation. The Contractor shall coordinate all testing and installation procedures with the City and County of Denver's Department of Transportation & Infrastructure Transportation Operations staff. The Contractor shall contact Denver Traffic at (720) 865-4002 for all testing and installation requirements.

The controller shall be installed in accordance with the details shown in the plans and in accordance with manufacturer's recommendations.

Subsection 614.10 shall include the following:

The Contractor shall demonstrate successful traffic signal operations at all new controller and cabinet locations to the satisfaction of the Engineer or Engineer's designee prior to acceptance of this item. The Contractor shall contact the Engineer or Engineer's designee 3 days before turning on signal. Work shall include all required programming of controllers and establishing or re-establishing all required wiring connections. Phasing and timing information at each location shall be furnished to the Contractor by the City & County of Denver.

All new wiring shall conform to City & County of Denver and International Municipal Signal Association (IMSA) specifications.

Subsection 614.13 shall include the following:

The unit price for the installation of Traffic Signal Controller Cabinet shall include all labor, materials, ancillary hardware, traffic signal cabinet base, wiring and wiring re-connection (including Xcel Energy power feed) required to provide and install a complete system and successful operation of the item. Connection of the controller to the fiber optic interconnect system shall be paid for separately.

Subsection 614.14 shall include the following:

Pay Item	Pay Unit
Traffic Signal Controller and Cabinet	Each

Revision of Section 614
Traffic Signal Cabinet Base

Section 614 of the Standard Specifications is hereby revised for this project as follows.

Subsection 614.01 shall include the following:

This work is of the installation of a composite Traffic Signal Controller Cabinet Base in accordance with City & County of Denver standards. The Contractor shall furnish and install the base that will fit the City and County of Denver's P-size traffic signal controller cabinet at the locations as shown on the plan.

Dimensions of the cabinet base are as shown in City and Country of Denver Traffic Engineering Services STD DWG NO. 16.1.16.

Subsection 614.10 shall include the following:

Prior to starting cabinet base installation, Contractor shall obtain field verification of the location of the cabinet from the Engineer.

Cabinet base installation shall include all labor and materials to completely install a new P-size cabinet base as directed in the plans. The item shall include all excavation, conduit installation and modification work, backfill and restoration of adjacent surface area.

Subsection 614.13 shall include the following:

Installation of the traffic signal cabinet base shall not be measured and paid for separately but shall be included in the cost for installation of the Traffic Signal Controller Cabinet.

Subsection 614.14 shall include the following:

Installation of the traffic signal cabinet base will not be measured and paid for separately but shall be included in the cost of the Traffic Signal Controller and Cabinet.

Revision of Section 614
Pedestrian Push Button Post Assembly

Section 614 of the Standard Specifications is hereby revised for this project as follows

Subsection 614.08 (h) shall include the following:

Pedestrian Push Button Post Assembly. Pedestrian Push Button Post Assembly shall conform to the requirements of the City and County of Denver's Standard Detail 7, Standard drawing No. 16.1.14. Pedestrian Push Buttons and Signs shall be handled through other items.

Subsection 614.13 shall include the following:

Pedestrian Push Button Post Assembly shall be measured by the number of units installed and shall include post, foundation and all work necessary to complete the item.

Subsection 614.14 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Pedestrian Push Button Post Assembly	Each

1

Revision of Section 614
Emergency Vehicle Traffic Signal Priority Control System

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.08 shall include the following:

System Description:

The emergency vehicle traffic signal priority control system shall enable designated vehicles to remotely cause the traffic signal controller to advance to and/ or hold a desired traffic signal display by using existing controller functions. The control shall be activated at a minimum distance of 548.6M (1,800 feet) along an unobstructed "line of sight" path. The control shall not terminate until the vehicle is within 12.2M (40 feet) of the detector or at the intersection.

The system shall consist of the following components:

A. Vehicle Emitter which shall be mounted on the emergency vehicle and shall transmit optical energy signals only in the forward direction. If the municipality presently uses optical pre-emption, the emitters hall be the same manufacturer currently used by the City and County of Denver Fire Department.

B. Phase Selector (minimum 2 channels) which shall cause the signal controller to advance to and/ or hold the desired traffic signal display for the emergency vehicle. A pre-emption system chassis shall house two phase selectors.

C. Optical Detector which shall be mounted on or near a traffic signal and shall received the optical energy signals generated by the Vehicle Emitter.
    a. Detector (Type A), 1 Direction, 1 Channel
    b. Detector (Type B), 2 Direction, 1 Channel
    c. Detector (Type C), 2 Direction, 2 Channel

D. Detector Cable (Optical).

System Operations:

A. The operating sequence shall be initiated when the optical detector receives the required optical energy signal from the Emitter.

B. The phase selector shall cause the traffic signal controller to advance to and/ or hold the desired traffic signal display for the emergency vehicle.

2
Revision of Section 614
Emergency Vehicle Traffic Signal Priority Control System

C. The phase selector shall cause the controller to advance to and/ or hold the desired traffic signal display even if the optical energy signals cease before the desired display is obtained.

D. The phase selector shall allow the traffic signal controller to resume normal operation within ten seconds after optical energy signals cease if the optical energy signals cease after the desired traffic signal display is obtained.

E. The phase selector shall not respond to optical energy signals from an emergency vehicle if it is already processing optical energy signals from another emergency vehicle.

System Components:

A. Vehicle Emitter:

The emitter assembly consists of an emitter and power supply and an emitter control switch assembly. The emitter assembly is mounted on a vehicle and produces a flashing optical signal when in operation. The following shall apply to the vehicle emitter:

1. Shall operate on ten to fifteen volts DC input voltage, but shall not be damaged by input voltage surges up to twenty-five volts DC.

2. Shall be controlled by a single on/off switch that requires no other adjustments by the operator. The on/off condition shall be indicated by a light located adjacent to the switch.

3. Shall be automatically disabled or de-activated by one or a combination of the following: seat switch, emergency brake switch, door switch, and transmission safety switch.

4. Shall operate over an ambient temperature range of minus 34O C to plus 60O C. (minus 30O F. to plus 140O F.)

5. Shall operate in 0 to 95 % humidity.

6. Shall be a pulsed optical energy source with a controlled repetition rate.

7. Shall not generate voltage transients on the battery input line which exceed battery voltage by more than four volts.

3
Revision of Section 614
Emergency Vehicle Traffic Signal Priority Control System

8. Shall produce optical energy in a cone of not more than 90 degrees horizontal and not more than 30 degrees vertical. The detectors and/ or phase selector shall not sense a pre-emption signal from an emitter outside this cone.

B. Optical Detector:

The optical detector receives the high intensity optical pulses produced by the emitter. These optical energy pulses are transformed by the detector into appropriate electrical signals which are transmitted to the phase selector. The optical detector is mounted at or near the intersection in a location which permits an unobstructed line of sight to vehicular approaches. The units may be mounted on signal span wires, mast arms or other appropriate structures. The following shall apply to the optical detector:

1. Shall produce optical energy in a cone of not more than 90 degrees horizontal and not more than 30 degrees vertical. The detectors and/ or phase selector shall not sense a pre-emption signal from an emitter outside this cone.
2. Shall be of solid state construction.
3. Shall operate over an ambient temperature range of minus 34O C to plus 60O C. (minus 30O F. to plus 140O F.)
4. Shall have internal circuitry potted in a semi-flexible compound to ensure moisture resistance.
5. Shall operate in 0 to 95 % humidity.
6. Shall have a cone of detection of not more than 13 degrees. The detector and/ or phase selector shall not sense a pre-emption signal from an emitter outside this cone.

C. Phase Selector:

The phase selector supplies power to and receives electrical signals from the optical detector. When detector signals are recognized as a valid call, the phase selector causes the signal controller to advance to and/ or hold the desired traffic signal display. This is accomplished by activating the pre-empt input to the controller.

The phase selector is capable of assigning priority traffic movement to one of two channels on a first-come, first-serve basis. Each channel is connected to select a particular traffic movement from those normally available within the controller. Once a call is recognized, "commit to green" circuitry in the phase selector functions so that the desired green indication will be obtained even if optical communication is lost. After serving a priority traffic demand, the phase selector will release the

4
Revision of Section 614
Emergency Vehicle Traffic Signal Priority Control System

controller to follow normal sequence operation. The following shall apply to the phase selector:

1. Shall include an internal power supply to supply power to the optical detectors.
2. Shall have minimum two-channel operation with the capability of interfacing with an additional phase selector for expansion of channels of operation.
3. Shall have adjustable detector range controls for each channel of operation, from 12M (40 feet) to 548M (1800 feet).
4. Shall have solid state indicator lights for power on and channel called.
5. Shall operate over an ambient temperature range of minus 34O C to plus 60O C (minus 30O F. to plus 140O F.).
6. Shall operate in 0 to 95 % humidity.

D. Detector Cable (Optical):

The following shall apply to the detector cable:

1. 3-Conductor cable with shield and ground wire.
2. AWG #20 (7x28) stranded.
3. Individually tinned copper strands.
4. Conductor insulation: 600 volt, 75 deg. C (167O F.).
5. 1 Conductor-yellow; 1 Conductor-blue; 1 Conductor-orange.
6. Aluminized Mylar shield tape or equivalent.
7. AWG #20 (7x28) stranded uninsulated drain wire
8. DC resistance not to exceed 11.0 ohms per 305M (1000 feet).
9. Capacitance from one conductor to other two conductors and shield not to exceed 157pf/M (48pf /ft.).
10. Jacket: 600 volts, 80 deg. C (176O F.), minimum average wall thickness - 1.14mm (.045").
11. Finished O.D.: 7.62mm (0.3 inches) max.

System Interface:

System shall be capable of operating in a computerized traffic management system when appropriate interfacing is provided by the computer supplier.

General:

The Contractor shall furnish the manufacturer the phasing diagrams indicating controller sequence and timing.

5
Revision of Section 614
Emergency Vehicle Traffic Signal Priority Control System

The Contractor shall secure from the manufacturer a guarantee for the equipment for a period of sixty (60) months, which time shall commence from the date of delivery. Manufacturer shall certify upon request that all materials furnished will conform to this specification. The manufacturer or his designated representative shall be responsible for determining and setting all required range and emitter intensity for the emergency vehicle operation.

Construction Methods:

All equipment except the vehicle emitter assembly shall be installed and wired in a neat and orderly manner in conformance with the manufacturers' instructions. The vehicle emitter assembly shall be delivered to a designated City representative.

Installation of the vehicle emitter assembly shall be the responsibility of the City and County of Denver Fire Department.

Traffic signals owned and maintained by the city do not require an AEC to house the pre-emption equipment.

Detector cables shall be continuous with no splices between the optical detector and the AEC.

Detector locations shown on the plan are for illustration purposes only. Exact location shall be determined by the contractor or the designated representative for the best possible line of sight.

- Controller "D" harness and adapter.
- Pre-emption termination panel with terminal block and relay bases.
- Pre-emption disconnect switch, mounted on the emergency switch panel (on inside of cabinet door).
- Pre-emption test buttons, mounted on the pre-emption termination panel.

All connections from the phase selector to the "D" harness and to the cabinet wiring shall be made at the termination panel. The termination panel shall have AC+ Lights, AC-, and a switched logic ground. The switched logic ground feeds all the pre-empt inputs to the phase selector. When switched off by the pre-emption disconnect switch, the traffic controller shall not be affected by pre-empt calls from the optical pre-emption system. A minimum of two test buttons shall be provided. If there are more than two pre-empt runs, a button for each shall be installed. A chart or print out indicating the program steps and settings shall be provided along with the revised cabinet wiring diagrams.

6
Revision of Section 614
Emergency Vehicle Traffic Signal Priority Control System

Test the Pre-emption System According to the following Guidelines:

1. Notify the system owner/user, such as the Municipal Fire Chief or City Traffic Engineer, of the scheduled inspection

2. Request a fire department representative and an emergency vehicle, which has an emitter to conduct the test. If not available, the contractor shall provide an emitter.

3. In the presence of the Engineer and the municipal representative, test each pre-emptied approach with the emergency vehicle. Test the following items of the system:

    a. Confirm that the emitter activates the phase selector and the phase selector activates the correct pre-emption input to the controller.

    b. Confirm adequate range. The traffic signal must be pre-empted to green sufficiently in advance of the emergency vehicle arrival. The vehicle emitter shall initiate pre-emption at a minimum distance of 548.6M (1800 feet).

    c. Confirm there are no false calls. Keep the emitter active as the emergency vehicle passes through the intersection. No other optical detectors shall sense the strobe.

4. Document the test. Provide the Engineer and, upon request, the municipality copies of the test results.

If a malfunction is found or the system needs adjustment (such as range, emitter intensity, or detector location), schedule a follow-up test. Repeat the above steps for all approaches that did not pass.

All adjustments such as emitter intensity, phase selector range, sensitivity, detector placement, shall be made at the intersection by the contractor so that the optical pre-emption operates correctly with other major manufacturers' equipment currently owned by the town.

Subsection 614.13 shall include the following:

Emergency Vehicle Traffic Signal Priority Control System units shall include a four-channel card and the number of detectors as shown on the plans. Emergency Vehicle Traffic Signal

7
Revision of Section 614
Emergency Vehicle Traffic Signal Priority Control System

Priority Control System shall be measured and paid by the number of intersections at which the system is installed. The item shall include all labor, materials, and ancillary hardware required to provide a fully functioning system to the satisfaction of the Engineer.

Subsection 614.14 shall include the following:

Pay Item	Pay Unit
Emergency Vehicle Traffic Signal Priority Control System	Each

1

Revision of Section 614
Traffic Signal Poles – General

Section 614 of the Standard Specifications is hereby revised as follows:

Subsection 614.08 (h) shall include the following:

This work is for the installation of the mast arm traffic signal poles, traffic signal light poles (no mast arm), traffic signal span wire poles (imbedded steel poles), and traffic signal pedestal poles. The Contractor shall furnish and install the traffic signal poles at locations as shown on the plans. All traffic signal poles shall be painted dark olive green in conformance with Federal Specification No. 14056.

The mast arm traffic signal poles and the traffic signal light poles (no mast arms) will be in accordance with the latest City and County of Denver's Traffic Standards and Specifications.

General specifications of the mast arm traffic signal poles, traffic signal light poles (no mast arms), traffic signal imbedded steel poles, and traffic signal pedestal poles are as follows:

TRAFFIC SIGNAL POLES: All traffic signal poles (imbedded poles, mast arm traffic signal poles, traffic signal light poles - no mast arms) shall conform to latest City and County of Denver's Traffic Standard Details 16.1.3 and 16.1.9.1 to 16.1.12.2.

Traffic Signal Pedestal Poles shall conform to the requirements of the City and County of Denver's Traffic Signal Standard Detail 16.1.13.1 to 16.1.13.2.

The Contractor shall furnish and install a 5300 Lumens LED luminaire at all traffic signal poles as shown on the plans or as directed by the Engineer. The LED luminaire shall be in accordance with the City and County of Denver's specifications and Sections 613 - LIGHTING (LUMINAIRE)(LED 5300 LUMENS). The luminaire shall be installed on the traffic signal poles with a 10-foot luminaire arm as per the City and County of Denver's Traffic Standard Details 16.1.3, and 16.1.9.1 to 16.1.12.2.

FINISH: All traffic signal poles and mast arms – except for the imbedded steel poles and the aluminum pedestal poles – shall be finish in hot dipped galvanized, epoxy primer, and powder coated in accordance with the Valmont F540 finish process or equal.

PAINTING: All traffic signal mast arm poles shall be powder coated in accordance with the following specifications:

General:
Super Durable Powder Coating: The super durable powder coating shall consist of a Urethane or TriglycidylIsocyanurate (TGIC) Polyester Powder, and provide a minimum of 3 times the gloss retention, color retention and ultraviolet light (UV) resistance as standard powder

2
Revision of Section 614
Traffic Signal Poles – General

coatings. Color shall be dark olive green, in conformance with Federal Specification No. 14056.

Surface Preparation:
The exterior steel surface shall be blast cleaned to Steel Structures Painting Council Surface Preparation Specification No. 6 (SSPC-SP6) requirements utilizing cast steel abrasives conforming to the Society of Automotive Engineers (SAE) Recommended Practice J827. The blast method is a recirculating, closed cycle centrifugal wheel system with abrasive conforming to SAE Shot Number S280.

Interior Color:
Interior surfaces (pole shafts only) at the base end for a length of approximately 2.0' shall be mechanically cleaned and coated with a zinc rich epoxy powder. The coating shall be electrostatically applied and cured in a gas fired convection oven by heating the steel substrate to a minimum of 350 degrees Fahrenheit and a maximum of 400 degrees Fahrenheit.

Exterior Coating:
All exterior surfaces shall be coated with Urethane or TriglycidylIsocyanurate (TGIC) Polyester Powder to a minimum film thickness of 2.0 mils (0.002 inches). The coating shall be electrostatically applied and cured in a gas fired convection oven by heating the steel substrate to a minimum of 350 degrees Fahrenheit and a maximum of 400 degrees Fahrenheit. The thermosetting powder resin shall provide both intercoat as well as substrate fusion adhesion that meets 5A or 5B classifications of ASTM D3359.

Packaging:
Prior to shipment, small poles shall be wrapped in 0.188 inch thick Ultraviolet inhibiting plastic backed foam. Larger poles shall be cradled in a 1.0 inch rubberized foam base.

Handling and Shipment:
Poles shall be handled in a manner that will preserve the overall appearance and prevent damage to the coating. The use of chains or cables for loading, unloading, or installing is prohibited. Only ¾ inch diameter or larger nonabrasive nylon rope or equivalent nylon belting will be used. Adequate hold-downs and appropriate blocking shall be utilized for shipping to prevent load movement and damage to the outer coating in transit. No handling should be allowed until "dry through" condition has been achieved with the coating.

Extra care will be taken not to damage the coating. Upon arrival of the poles at the delivery point, neither chains nor cables will be used to either unloading or installation of poles.

3

Revision of Section 614
Traffic Signal Poles – General

Procedure for Field Touch-Up:
The pole manufacturer will furnish extra paint, both primer and color coat, to satisfy the needs of field touch-up requirements, in the event of minor physical damage to the coating from handling or transit. Damaged area must be clean and dry before repair application. Field touch-up will be at the direction of the pole manufacturer or their authorized representative.

Subsection 614.14 shall include the following:

Pay Item	Pay Unit
Traffic Signal-Light Pole Steel (1-20 Foot Mast Arm)	Each
Traffic Signal-Light Pole Steel (1-25 Foot Mast Arm)	Each
Traffic Signal-Light Pole Steel (1-40 Foot Mast Arm)	Each
Traffic Signal-Light Pole Steel (1-45 Foot Mast Arm)	Each

1
Revision of Section 614
Uninterrupted Power Supply System

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.08 shall include the following:

1.1 SUMMARY

A. Scope: This specification describes the operation and functionality of a continuous duty, single-phase Uninterruptible Power Supply unit, hereafter referred to as the UPS.

B. Included Features of the UPS:

1. The UPS utilizes double conversion online topology designed to protect electronic equipment by supplying reliable, clean power featuring extremely tight voltage and frequency regulation.
2. Wide operating temperature range -40C to 74C.
3. Field replaceable air filter.
4. Field replaceable fan assembly.
5. The UPS features internal bypass and input power factor correction.
6. The primary sections of the UPS are: input disconnect and filter stage, input PFC power stage, energy storage stage (DC bus capacitor bank), output power (inverter) stage, bypass and a bidirectional DC-DC converter / battery charger. The control of power module and fault detection logic is microcontroller-based.
   a. The input disconnect and filter stage contains an input back-feed relay, input filter and transient suppression.
   b. The input PFC power stage contains non-isolated power factor correcting AC/DC converters. This converter is capable of full power operation over a very wide input voltage range.
   c. The energy storage stage is a split DC bus capacitor handling seamless transitions from battery to line and vice versa, as well as the low and high frequency power stages.
   d. The output power stage operates directly from the DC bus and develops an output of 120V AC ,60Hz. The AC output of the inverter is connected to bypass relay. The bypass relay output is routed to the output terminals of the UPS.
   e. The UPS contains a battery charger, which operates from the DC bus. The UPS can be restarted immediately after a prolonged power outage without waiting for the battery to be recharged.
7. The UPS provides early-warning fault analysis on batteries and will project battery replacement dates, enabling timely preventive maintenance.
8. The UPS has flash memory to facilitate firmware upgrades.

2
Revision of Section 614
Uninterrupted Power Supply System

9. The graphical LCD display with multicolor backlight provides detailed information, with the ability to configure the display locally.

10. An integrated Network Management Card 2 (reference APC part # AP9537SUM-FC) with Environmental Monitoring is embedded into the UPS.

C. Performance, Design, and Configurations: The UPS and associated equipment operates in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for mission-critical, electronic equipment and other load devices.

1. This specification describes the performance, functionality, and design of the UPS, the external Battery Systems, and connectivity solutions.
2. All programming and miscellaneous components for a fully operational system as described in this section are available as part of the UPS.
3. The UPS and battery packs are available in the following configurations:

Type	Model	SKU
UPS	APC SECUREUPS 1300VA / 1300W, 120VAC IN/OUT RM CONFORMAL COATED	XU1K3LLXXRCC
ACCESSORIES	APC SECUREUPS BATTERY HARNESS SBS75 CABINET ACCESORY 8FT	XHHXS7A8F
	APC SECUREUPS BATTERY HARNESS SBS75 CABINET ACCESORY 4FT	XHXXS7A4F
	APC SECUREUPS BATTERY HEATER MAT 256 SQ IN 115/120VAC SINGLE PHASE IN CABINET ACCESSORY	XM050DXXXA
	APC SECUREUPS BATTERY HEATER MAT 365 SQ IN 115/120VAC SINGLE PHASE IN CABINET ACCESSORY	XM102DXXXA
	APC SECUREUPS BATTERY 50AH 12VDC EXTENDED TEMPERATURE SHELF MOUNT	XB050XX1XS
	APC SECUREUPS BATTERY 100AH 12VDC EXTENDED TEMPERATURE SHELF MOUNT	XB102XX1XS

3

Revision of Section 614
Uninterrupted Power Supply System

1.2 REFERENCE

A. **General:** The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications is the latest date as of the date of the Contract Documents, unless otherwise specified.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. ANSI/IEEE 519, "Guide for Harmonic Control and Reactive Compensation of Static Power Converters" (copyrighted by IEEE, ANSI approved).

C. International Organization for Standardization (ISO):

1. ISO 9001, "Quality Management Systems - Requirements."

2. ISO 14001, “Environmental Management Systems - Requirements with Guidance for Use.”

1.3 STANDARDS

A. Regulatory Compliance:

Model Description	SKU	Approvals
APC SECUREUPS 1300VA / 1300W, 120VAC IN/OUT RM CONFORMAL COATED	XU1K3LLXXRCC	UL, cUL/CSA UL-1778 (CSA 107.3 for Canada), IEC62040-2 2005 Edition and FCC Part 15 Class A,

1.4 SYSTEM DESCRIPTION

A. Mechanical Design

1. The UPS is contained in a Powder coated steel chassis with plastic display panel embedded into the chassis.

2. The UPS has a field replaceable filter and fan assembly.

3. The chassis weights and dimensions are:

4

Revision of Section 614
Uninterrupted Power Supply System

Description	SKU	Weight kg (lb)	Height mm (in)	Width mm (in)	Depth mm (in)
APC SECUREUPS 1300VA / 1300W, 120VAC IN/OUT RM CONFORMAL COATED	XU1K3LLXXRCC	10.0 (22.0)	88 (3.46)	432 (17.0)	260 (10.2)

B. System Characteristics

1. General:

a. Power Rating: 1300VA/1300W
b. Output power factor :1
c. Charger Power: 750 Watts
d. Topology: Double Conversion On-Line
e. Cooling: Fan cooled

2. Online Efficiency: The UPS efficiency stated here is at full load and without degradation of output regulation as specified. Efficiency is 89% at rated load.

3. Input:

a. AC Input Nominal Voltage: 120 V.
b. AC Input Voltage Window:
   1) Full Load, 85-155 V +/- 2V, 5 V hysteresis.
c. Input Frequency Range: 40 – 70 Hz, auto-selecting.
d. Online Input Power Factor: 0.95% for Full Charger power Load and > 75% Loads.
e. Input Current Distortion: <5% for 100% load.
f. Input Circuit Breaker (UPS): 30A UL Listed
g. Input Surge Protection: 432 Joules.

4. UPS Output:

a. Nominal Output Voltage: 120 V
b. Output Connector: Terminal Block - Hardwire
c. Output Frequency: 50/60 +/- 3Hz (auto-sense); 50/60 +/- 0.1 Hz (user-selectable).
d. Output Frequency Regulation: Free Running: Nominal +/- 0.1 Hz.
e. AC output voltage distortion:
   1) 5% @ 100% full linear load; 10% @ 100% full non-linear load.
f. AC output static voltage regulation: ± 1%.
g. AC output dynamic voltage regulation: ± 5% rms in 2cycles for 10% to 90% resistive load step of the initial value.

5
Revision of Section 614
Uninterrupted Power Supply System

h. Output Voltage Harmonic Distortion:
   1) <5% THD for a 100% linear load.
   2) <10% THD for a 100% non-linear load.
i. Overload Rating: % and duration
   1) Normal Operation (Online):
      a) 120Vac: 105% No Limit; 125% for 1min, 150% for 30 seconds and >175% on AC for 500mSec.
   2) Bypass Operation: Overload is limited by the internal 30A input circuit breaker feeding the UPS:
      a) Bypass is internal
      b) Voltage range: 120Vac 86-148Vac,.
      c) Frequency range: 47-53 Hz or 57-63 Hz based on bypass frequency setting.
      d) Transfer time: To Bypass mode – 15ms max.
      e) Transfer time: Bypass to Online mode – 15ms max.
      f) Bypass can be commanded through the diagnostic menu
j. Derating over temperature: Supports 100% load at 65 °C, Linearly de rate to 70% load at 74 °C.
k. Output Load Power Factor Rating:
   1) 0.7 lagging to 0.7 leading.
l. Crest Factor: 3:1

5. Charger:
a. Nominal Battery Voltage: 48 V.
b. Charger capacity: 850W Max, 15A Max, whichever is applicable.
c. Runtime at 100% load: >2 hours for 100Ah battery

6. Battery: Not supplied with UPS sold as an accessory, user must select the rating of the battery AH though the UPS user interface.
Battery Types available: Sealed maintenance free valve regulated lead acid battery (VRLA) with suspended electrolyte, leak proof:
1) 100 Ah qty 4 required for 48 Vdc battery system
2) 50 Ah qty 4 required for 48 Vdc battery system

1.5 SUBMITTALS

A. Proposal Submittals:
1. Product catalog sheets or brochures.
2. Product guide specifications.
3. Product technical specifications.
4. System package submittal drawings including a single-line and mechanical diagrams.

6
Revision of Section 614
Uninterrupted Power Supply System

B. Delivery Submittals:

1. User Manual: which includes safety information, specifications, UPS features, configuration, UPS settings and troubleshooting information, accessories details, installation details, and start-up of UPS.

1.6 PROJECT CONDITIONS

A. Environmental Requirements: The UPS is designed to be installed inside an Intelligent Traffic System cabinet i.e. NEMA, Caltrans etc. The cabinet should be weather proof and have particulate filtering in lieu of the filtering provided by the UPS. The UPS should be kept dry as possible if being serviced in wet weather. The UPS is capable of withstanding any combination of the following environmental conditions in which it must operate without mechanical or electrical damage, or without a need for de-rating of the output Power.

- **a.** Storage Ambient Temperature: -45 to 85°C UPS only (without batteries)
- **b.** Operating Ambient Temperature: -40°C to 74°C (LCD display -20 to 70°C)
- **c.** Relative Humidity: 0% to 95% non-condensing.
- **d.** Altitude:
  - **1)** Storage Altitude: 0 to 50,000 feet (0 to 15,000 meters) above sea level
  - **2)** Operating Altitude: 0 to10,000 feet (0 to 3000 meters) above sea level. At altitude of 10,000 feet the UPS must be loaded only up to 90% of its nominal capacity.
- **e.** Audible Noise:
  - **1)** <55 dBA at 100% load at 3 ft (1 m).
- **f.** Protection Class: IP 20.

1.7 WARRANTY

A. Limited Warranty: Schneider Electric IT Corporation (SEIT) warrants the UPS to be free from defects in materials and workmanship for a period of 3 years from the date of purchase,

1. Warranty Limitations:

- **a.** The obligation of Schneider Electric IT Corporation (SEIT) under this warranty is limited to repairing or replacing, at its own sole option, any defective product.
- **b.** This warranty does not apply to equipment that has been damaged by accident, negligence, or misapplication or has been altered or modified in any way.
- **c.** This warranty applies only to the original purchaser who must have properly registered the product within 10 days of purchase.

7
Revision of Section 614
Uninterrupted Power Supply System

-6-
REVISION OF SECTION 614
UNINTERRUPTED POWER SUPPLY SYSTEM

d. EXCEPT AS PROVIDED HEREIN, Schneider Electric IT Corporation (SEIT) MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Some states do not permit limitation or exclusion of implied warranties; therefore, the aforesaid limitation(s) or exclusion(s) may not apply to the purchaser.

e. EXCEPT AS PROVIDED ABOVE, IN NO EVENT WILL Schneider Electric IT Corporation (SEIT) BE LIABLE FOR DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OF THIS PRODUCT, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE. Specifically, Schneider Electric IT Corporation (SEIT) is not liable for any costs, such as lost profits or revenue, loss of equipment, loss of use of equipment, loss of software, loss of data, costs of substitutes, claims by third parties, or otherwise.

f. This warranty gives you specific legal rights and you may have other rights that vary from state to state.

2. Warranty Procedures:

a. To obtain service under warranty the purchaser must obtain a Returned Material Authorization (RMA) number from customer support.

b. Products must be returned with transportation charges prepaid and must be accompanied by a brief description of the problem encountered and proof of date and place of purchase.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Products specified is SECUREUPS Uninterruptible Power Supply Unit as manufactured by APC by Schneider Electric and as listed on page 2 of this specification. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The Architect/Engineer will be the sole judge of the basis of what is equivalent.

2.2 MODES OF OPERATION

A. Normal: The UPS output power stage (inverter) constantly recreates the UPS

8
Revision of Section 614
Uninterrupted Power Supply System

output AC voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT switches. In both online operation and battery operation, the output power stage (inverter) creates an output voltage waveform independent of the mains input voltage waveform. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages do not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output power stage (inverter). The input Power Factor Correction (PFC) power stage and the output power stage (inverter) operate in an on-line manner to continuously regulate power to the critical load. The input PFC stage is capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.

1. Overload Capability: See above specification
2. Output Relay: The output power stage (inverter) is equipped with an output mechanical relay to provide physical isolation of the inverter from the critical bus. The UPS when installed with Bypass Panel, allows the user to replace the failed UPS from the critical bus without interruption.
3. Battery Protection: The inverter is provided with monitoring and control circuits to limit the level of discharge on the battery system. The UPS employs a DC Breaker to protect the system from shorting of the battery supply. The battery harness which is sold as an accessory employs fuse protection.

B. Battery: Upon failure of the AC input source, the critical load continues being supplied by the output inverter, which derives its power from the battery system. There is no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to normal operation.

1. The UPS battery system and battery harness are sold separately as accessories. Batteries can be purchased in a 50 Ah or 100 Ah configuration, a total of 4 batteries are need to create the 48VDC that the UPS battery input requires. These replacement batteries are user-replaceable.
2. The batteries of the UPS models in this specification are maintenance-free, leak-proof, valve-regulated lead-acid (VRLA) batteries with suspended electrolyte.
3. The UPS incorporates the Intelligent Battery Management system to continuously monitor the health of the battery system. This UPS notifies the user in the event that a failed or weak battery is found.
4. The UPS is not shipped with batteries; they must be purchased separately.

C. Charging: Upon restoration of the AC input source, the UPS simultaneously recharges the battery and provides regulated power to the critical load.

1. The intelligent battery management system contains a temperature

9
Revision of Section 614
Uninterrupted Power Supply System

monitoring circuit and temperature compensation algorithm that regulates the battery charging voltage and current so as to optimize battery life.

2. The battery charging circuit remains active when in bypass or online states.

3. The UPS can be restarted immediately after a prolonged power outage without waiting for the battery to be recharged.

D. Bypass: During bypass operation the utility power is connected to the load, bypassing the internal converters. The system automatic bypass provides a transfer of the critical load from the Inverter output to the automatic bypass input source during times when the inverter cannot support the load. The design of the automatic bypass switch power path consists of a bypass relay.

1. Automatic Transfers: An automatic transfer of load to bypass takes place if the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from bypass back to normal operation takes place when the overload condition is removed from the critical bus output of the system or when other causes are corrected. When the system is in bypass mode, if bypass line becomes unavailable, the UPS will automatically switch to Online mode operation. In the event that mains power is unavailable the UPS will switch to battery power.

2. Manual Transfers: Manually initiated transfers to and from bypass may be initiated by the user display interface.

2.3 INPUT PFC POWER STAGE

A. General: The input Power Factor Correction (PFC) power stage of the UPS constantly rectifies the power imported from the mains input of the system, converting input mains AC power to DC power for precise regulation of the DC bus voltage, battery charging, and output power stage (inverter) regulated output power.

B. Input Current Total Harmonic Distortion: The input current THDI at full system load will be held to 7% at 50% load and 5% at full load while providing conditioned power to the critical load bus and charging the batteries under steady-state operating conditions. This is true while supporting loads of both a linear or nonlinear type. This will be accomplished with no additional filters, magnetic devices, or other components.

C. Input Current Limit:

1. In cases where the source voltage to the UPS is nominal and the applied UPS load is equal to or less than 100% of UPS capacity, input current will not exceed 178% of UPS output current, while providing full battery recharge

10
Revision of Section 614
Uninterrupted Power Supply System

power and importing necessary power for system losses.

D. Charging:
1. The battery charging circuit contains a temperature monitoring circuit, which regulates the battery charging current to optimize battery life.
2. The battery charging circuit remains active when the UPS is in automatic bypass and in normal operation
3. The UPS charging circuit can deliver charge current at 15 Amps. Charge current is automatically adjusted with battery Ah, temperature and load.

2.4 OUTPUT POWER STAGE (INVERTER)

A. General: The UPS output power stage (inverter) constantly recreates the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT-driven power converters. In both normal operation and battery operation, the output power stage (inverter) creates an output voltage independent of the mains input voltage. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages, shall not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output power stage (inverter).

B. Overload Capability: The output power stage (inverter) is capable of withstanding 150% overload for 30 seconds or 125% overload for 1 minute or 105% overload for indefinite length of time.

C. Output Relay: The output power stage (inverter) is equipped with an output mechanical contactor to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter will be removed from the critical bus. The UPS when installed with Bypass panel, has the provision of isolating the defective UPS from the critical Bus. This is achieved through Contactors used in the Bypass panel. This feature allows the user to replace the defective UPS without disrupting the power to the critical loads.

D. Battery Protection: The inverter is provided with monitoring and control circuits to limit the level of discharge on the battery system. The UPS comes with a 48 Vdc breaker to protect the battery supply. The battery harness is fused adding an additional layer of protection.

2.5 DISPLAY AND CONTROLS

A. Control Logic: The UPS is controlled by an embedded microcontroller which

11
Revision of Section 614
Uninterrupted Power Supply System

performs the following functions:
1. Monitoring the quality of the output voltage.
2. Monitoring vital parameters of the UPS.
3. Executing the state machine.
4. Intelligent battery management.
5. Controlling the input and output power stage.
6. Remaining runtime calculation.
7. Self-diagnostics, self-test, and proactive fault detection.
8. Communication to the integrated Network Management Card.

B. Display Interface: Located on the front of the UPS is an LCD user display comprised of a graphical, high resolution (3 inchesx3 inches) LCD (256 x 128 Pixels) and 5 pushbutton switches.
Control Functions: The following controls functions can be accomplished by use of the pushbutton switches:
1. POWER ON/OFF button.
2. Escape button.
3. OK button.
4. Up button.
5. Down button.

C. LED Status: Located 4 Led's on the front of the UPS to read the status of the secure UPS
1. Green LED - Output ON
2. Yellow LED - SecureUPS notification
3. Red LED - Unit needs attention
4. Blue LED - Information

D. Data displayed on the Display Interface: The following indicators are available on the Display Interface Unit:
1. Load icon and disable/mute audible alarm icon.
2. The UPS status information (Input and Output Voltage, Battery voltage and Load,).
3. Operation mode (On-Line mode, Bypass mode, and Battery mode).
4. Battery status icons.
5. Output relay Icon (Open/Close).
6. Backlight screens: Amber is an indication that requires attention and Red indicates a UPS alarm that requires immediate attention

E. Audible Alarms: Using audio signal, the UPS will notify the user about important events. The following is the list of distinct audio alarms:

12
Revision of Section 614
Uninterrupted Power Supply System

1. The UPS is on battery.
2. The UPS is on battery and the remaining battery capacity is low.
3. The UPS has shut down due to low battery capacity.
4. The battery needs to be replaced.
5. The UPS is overloaded.
6. The UPS is in fault state.

F. Output Relays: The UPS provides 6 programmable Output relay ports on the front panel. The following function can be programmed to each output relay.
1. On Battery
2. On Battery Peak
3. Low Battery
4. Alarm
5. Fault
6. Output ON
7. Output Off
8. Online (Inverter Mode)
9. Bypass
10. Timer – Peak load, ON battery,

G. Input Contacts: The UPS provides 2 programmable Input contacts on the front panel:
The following function can be programmed to each input contacts.
1. Self-Test
2. Alarm ON (External Alarms to System)
3. Alarm OFF (External Alarms to System)
4. Output ON
5. Output OFF

H. Flash Mode Setting:
1. Signal flash Voltage (Battery Voltage): Can be configured by the user to enable the flash mode operation.
2. For details of the available settings refer to the operation manual.

I. Communication Interface: For purposes of remote communications with the UPS the following are available and contained within the UPS:
1) The UPS has the following ports available; serial port (RJ45 – for manufacturing purposes only, USB Host port for use with a USB flash drive.
2) Ethernet Port allows communications over a network via web browser or SNMP or with APC StruxureWare™ management software.
3) Universal I/O port can be used to connect Temperature/Humidity sensors for

13
Revision of Section 614
Uninterrupted Power Supply System

environment monitoring.

2.6 BATTERY

A. The UPS does not ship with batteries. Batteries can be purchased separately and are available in 50 Ah and 100 Ah formats. Other amp hour types can be used but the user must program the battery amp hour into the UPS to ensure appropriate charging of the battery system.
B. Battery Temperature Sensor connector – Used with the battery system, monitors the temperature of the battery system which is used by the UPSs temperature compensated charger circuitry.
C. The batteries are of the valve regulated lead acid (VRLA) type. The following are the recommended Batteries for different AH.
   50Ah: XB050XX1XS
   100Ah: XB102XX1XS

2.7 SMART BATTERY MANAGEMENT

A. Features:
   1. Monitors and informs the user of the health of each battery system.
   2. Monitors and shows on the UPS Display Interface screen the date for the end of useful life for the battery system.
   3. Emits an alarm and shows a message on the UPS Display Interface screen to indicate the estimated battery end of life. On the UPS Display Interface screen, the user can set the number of days before the alarm is heard and the message appears on the UPS Display Interface screen.
   4. Monitors the temperature of the battery system and automatically adjusts the battery charging.
B. Maintenance:
   1. Uses sealed lead acid battery cells and does not require maintenance.
   2. Runtime Test (Calibration): This should be performed anytime the steady state load is changed significantly, for example when a new load is added to or removed from the UPS.
   3. Battery health monitoring: The battery energy output and voltage are monitored to assess the health of the installed batteries when the UPS is operating on battery.
   4. Battery health monitoring is done during a UPS Self-Test and also during a Runtime Calibration Test. These Self-tests are activated when the UPS is operating on battery power. The UPS can be configured to perform periodic, automatic Self Tests.
C. End of useful life

14
Revision of Section 614
Uninterrupted Power Supply System

1. Near end of life notification: A warning message will appear on the UPS display interface screen when the battery system is approaching the end of its useful life. For configuration details refer to Replacement Notification Time and Replacement Battery Alarm Time. The estimated replacement date for the battery system is available through the UI.
2. Needs replacement notification: The UPS display interface screen shows when the battery system replacement is required. All the four batteries must be replaced immediately after the notification.
   CAUTION: Continued operation after end of useful life notification may cause damage to the batteries.
3. Recycling: Please recycle the battery system.

PART 3 - ACCESSORIES

3.1 BATTERIES

The Battery supplied by the vendor shall meet, at a min, the following requirements

A. Battery Type:
   1. Be deep discharge rated and the battery enclosure shall be made up flame arresting, self-sealing, valve regulated lead acid (VRLA) batteries. The batteries shall have a high rate of discharge and be superior in rate of charge absorption. The internal construction shall be of Absorbent Glass Mat (AGM). The battery container shall be made up of flame retardant material. The batteries shall be hermetically sealed, when subjected to extreme condition, the hydrogen gas emitted shall not be more than 10 ppm. The supplied batteries are designed to be installed in any position without any leakage.

15
Revision of Section 614
Uninterrupted Power Supply System

B. Battery Specification:

Capacity (Ah) 20 hrs to 1.8 Vpc at 77° F	Nominal Voltage (V)	Power Per Cell (W) 20 Min to 1.67 Vpc/cell	Weight (Kg)	Length (Inches)	Width (Inches)	Height (Inches)	Copper Inserted Terminals (inches)
50	12	111.5	16.6	9.02	5.43	8.07	0.63 - 0.236 T6
96	12	223	31	12.99	6.81	8.35	0.787-0.236 T11

C. Battery Status and Health:

1. The BBS shall have a provision to select the battery Ah capacity through User Interface on the front panel of the BBS. The BBS also shall have the run time prediction software and the remaining run time shall be displayed on the User Interface provided on the BBS. The BBS shall also have the provision for the user selectable temperature compensation settings for the optimal charging of the selected batteries. The BBS shall also include the battery life prediction analytics to determine the end of life of the connected batteries.

3.2 BATTERY HARNESS

The battery harness supplied by the contractor shall be designed to facilitate an easy connection and disconnection of the cables between the batteries and BBS system. Also, the harness should have a provision to seamlessly include an additional set of batteries. The harness should allow the replacement of the battery set without the use of tools. All the battery harness interconnected wiring shall conform to UL Style 1015 CSA TEW or equivalent. Wiring shall be of proper gauge with respect to design current and with sufficient strand count for flexibility.

A. Battery harness set:

1. The battery harness set consists of

a) 4 battery connection cables

b) 1 battery interconnection harness with a provision for BBS connection

c) 1 extension cable harness for installations where the distance between the batteries and the BBS is greater than the length of the battery interconnection harness

16
Revision of Section 614
Uninterrupted Power Supply System

2. Battery Connection Cables:

a) The battery connection cables consist of a pair of cables that connect to the battery positive and negative terminals. The other end of these two cables are terminated on a connector of the type SBS75 from Anderson connectors or equivalent. The battery side connection of the cables shall be provided with a ring lug with a provision for an M8 screw. The battery side ring lug must be secured with an insulating cap that covers the battery terminals when installed. The cap should provide protection against accidental contact with live terminals of the battery. The caps are ergonomically designed for easy installation and removal. The quality of the caps provided should withstand repetitive usage.

3. Battery Interconnection Harness

a) The main purpose of this harness is to facilitate the interconnection between batteries and the BBS system. The battery interconnection harness shall have mating connectors that match the connectors on the battery connection link and the BBS. The battery interconnection harness should include a 200 Amp fuse to protect against any short circuit on the BBS side. The battery interconnection harness should support the connection of an additional set of batteries.

4. Extension Cable Harness

a) The extension cable harness is to be installed along with battery interconnection harness for extending distance between the BBS and the battery bank. The cable ends are terminated on the matching connector to accommodate the BBS connection on one end and battery interconnection harness on the other end. Extension cable harness shall be 8 ft in length.

B. Other Harness Accessories included:

1. The other accessories to be included are battery cable hardware, cable ties, temperature sensor cables and any other accessory necessary for completing the installation.

3.3 SERVICE BYPASS UNIT

A. Service Bypass Unit (SBU):

17
Revision of Section 614
Uninterrupted Power Supply System

The SBU provides power to the critical load bus from the bypass source during times when maintenance or service of the BBS is required. The SBU provides a mechanical means of complete isolation of the BBS from the electrical wiring of the installation.

1. Output Specifications

	Parameter	Specification
1	Nominal Output Voltage (V)	120
2	Changeover Switch capacity (Amps)	30 (Minimum)
3	Output Current (Amps)	30
4	Output Connections	30 Amps, 3 Pole, Anderson quick disconnect type

2. Input Specifications

	Parameter	Specification
1	Nominal Input Voltage (V)	120
2	Input frequency (Hz)	50/60
3	Input Connections	30 Amps, 3 Pole, Anderson quick disconnect type
2	Load Power Factor Range	0 to 1
4	Maximum Input Current (Amps)	30

3. SBU Construction

a) The SBU is constructed in a rack-mounted 2U enclosure unless otherwise stated in this specification. This unit may also be mounted in a vertical orientation.

4. SBU Bypass Switch Type

a) The SBU shall have a manually operated rotary switch with MAKE BEFORE BREAK mechanism. The switch shall have two operating positions; Normal mode and Bypass mode. In Normal mode,

18
Revision of Section 614
Uninterrupted Power Supply System

power is directed from the utility outlet, through the bypass panel and BBS to connected equipment at the output of the SBU. In Bypass mode, power from the utility is directly fed to connected equipment. Also, in Bypass mode, the BBS shall be galvanically isolated from the SBU for safe maintenance or replacement

5. SBU and BBS Connection

a) The connection between SBU and BBS should be achieved with a single harness with an easy connect-disconnect facility. The easy connect-disconnect may be achieved by an Anderson Powerpole connector of adequate capacity. The construction and insulation levels of the Powerpole connectors should provide protection against accidental contact with live parts in the connector housing. The connectors should be ergonomically designed for an easy connect and disconnect operation. The connectors should also have a locking mechanism to avoid any loose contacts

PART 4 – EXECUTION

4.1 FIELD QUALITY CONTROL

A. Manufacturer Field Service:

1. Worldwide Service: The UPS manufacturer has a worldwide service organization available, consisting of factory-trained field service personnel to perform startup, preventive maintenance, and service of the UPS system and power equipment. The service organization offers service support 24 hours a day, 7 days a week, 365 days a year.

2. Replacement Parts: Parts are available through the worldwide service organization 24 hours a day, 7 days a week, 365 days a year. The worldwide service organization is capable of shipping parts within four working hours or on the next available flight, so that the parts may be delivered to the customer site within 24 hours.

4.1.1 MAINTENANCE

A. A complete offering of preventive and full service maintenance contracts for the UPS system and the battery system are available from APC by Schneider Electric. Contract work is performed by Schneider Electric factory-trained service personnel.

19

Revision of Section 614
Uninterrupted Power Supply System

Subsection 614.13 shall include the following:

The unit price for the furnish and install of the Uninterrupted Power Supply System shall be for a complete system and successful operation of the item. The UPS installation will be tested in accordance with this specification or as directed by the Engineer. The UPS system shall be measured and paid by the number of units installed. The item shall include all labor, materials, and ancillary hardware required to provide a fully functioning system to the satisfaction of the Engineer.

Subsection 614.14 shall include the following:

Pay Item	Pay Unit
Uninterrupted Power Supply	Each

1

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:

Subsection 614.01 shall include the following:

This work consists of furnishing and installing single mode fiber optic cable, tracer wire, and pull tape.

Fiber optic cable shall be used for either main backbone cable and/ or lateral cables that connect to equipment field cabinets.

Subsection 614.08 shall include the following:

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 current version and/ or revision of the following fiber optic industry standards:

(a) Electronic Industries Alliance (EIA)-359: Colors for Color Identification and Coding
(b) International Telecommunications Union – Telecommunications Standardization Sector - Recommendation G.652.D: Characteristics of a Single-Mode Optical Fibre and Cable
(c) Telecommunications Industry Association (TIA)-598: Optical Fiber Cable Color Coding
(d) TIA-455: General Requirements for Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components – Fiber Optic Test Procedures (FOTP) as listed below:
    1. FOTP-37 Low and High Temperature Cable/Maximum Bend Radius/Cable Aging
    2. FOTP-25 Impact Resistance
    3. FOTP-41 Compressive Strength
    4. FOTP-85 Cable Twist
    5. FOTP-104 Cable Cyclic Flexing
    6. FOTP-33 Maximum Tensile Load
    7. FOTP-3 Temperature
    8. FOTP-98 Cable Freezing
    9. FOTP-82 Water Penetration
    10. FOTP-81 Compound Drip Temperature
(e) International Organization for Standardization (ISO) – 9001: Quality Management Systems
(f) Rural Utilities Service (RUS) PE90a: Minimum Performance Specifications for Fiber Optic Cables
(g) Telcordia GR-20: Generic Requirements for Optical Fiber and Optical Fiber Cable

2

Revision of Section 614
Fiber Optic Cable (Single Mode)

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 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 Non-circularity: ≤ 1.0 %
5. Coating Diameter (Colored): 245 ± 5 µm
6. Maximum Attenuation (Loose Tube): 0.35 dB//km at 1310 nm wavelength and 0.25 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 / (nm2 * km)
12. Polarization Mode Dispersion: ≤ 0.06 ps/ √km
13. Maximum Polarization Mode Dispersion at 0.01% distribution (PMDq): 0.20 ps/√km
14. Maximum Fiber Dispersion: ≤ 18 ps/(nm*km) at 1550 nm.
15. Fiber Curl: ≥ 4.0 m
16. Proof Tensile Test: 100 kpsi (0.69 GN/m2)
17. The fibers shall not adhere to the inside of the buffer tube.
18. 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.
19. Each single mode fiber strand shall be color coded with distinct and recognizable colors in accordance with the TIA-598.

(b) Buffer Tubes

1. Each backbone buffer tube shall contain 12 fiber strands and each lateral fiber cable shall have either two buffer tubes with six fiber strands in each or one buffer tube with 12 fiber strands.
2. Optical fibers shall be placed inside a loose buffer tube.
3. Each buffer tube shall be color coded with distinct and recognizable colors in accordance with TIA-598
4. 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 and progress outward.

3
Revision of Section 614
Fiber Optic Cable (Single Mode)

5. Buffer tube black stripe shall be inlaid in the buffer tube material by means of co-extrusion when required.
6. 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. Colorings shall not cause fibers to stick together.
7. Each buffer tube shall contain dry 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 dry water blocking material shall be uniformly distributed throughout the buffer tubes.
8. Buffer tubes shall be stranded around a central member of the cable using a reverse oscillation stranding process.
9. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrink back requirements of RUS PE90a.

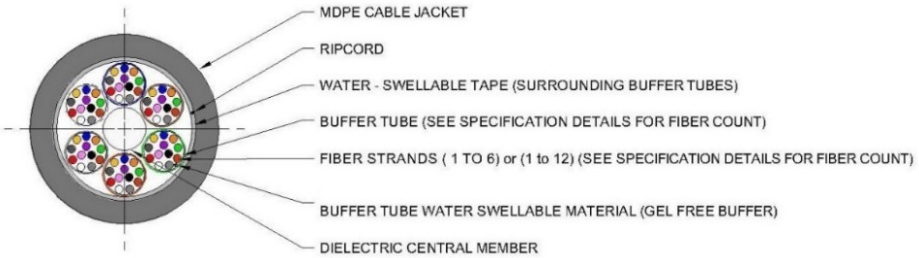
(c) Fiber Cable

1. 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.
2. The central anti-buckling member of the cable shall consist of all dielectric, glass reinforced plastic (GRP) rod.
3. 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.
4. When the fiber cable is provided with dual layer buffer tubes, both the inner and outer layer shall be provided with water swellable tape.
5. 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, and dielectric with low shrinkage.
6. The cable shall contain at least one ripcord under the sheath for easy sheath removal.
7. 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

4
Revision of Section 614
Fiber Optic Cable (Single Mode)

and water blocking tape. The MDPE jacket material shall be as defined by ASTM D1248, Type II, 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.

8. The cable jacket shall be free of holes, splits and blisters and be of a consistent thickness.
9. 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.
10. 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
(Source: CDOT)

11. The diameter of the fiber optic cables shall not exceed 0.50 inch for 12 single mode fibers and 0.55 inch for 96 single mode fibers.
12. The weight of the fiber optic cables shall not exceed 65 pounds/1,000 feet for 12 single mode fibers and 85 pounds/1,000 feet for 96 single mode fibers.
13. The maximum working tension of the fiber optic cable shall be 600 lbf.

(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)

5
Revision of Section 614
Fiber Optic Cable (Single Mode)

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.

(g) Tracer Wire and Pull Tape
1. The pull tape shall be a flat, woven, polyester tape with an insulated metallic conductor (tracer wire) interwoven within the tape.
2. It shall be lubricated to reduce friction.
3. It shall be durably printed with sequential footage markings.
4. It shall have a minimum tensile strength of 900 pounds.
5. The metallic conductor (tracer wire) shall be a minimum #22 AWG tin coated copper with an extrusion friendly copolymer insulation.

Subsection 614.10 shall include the following:

Fiber optic cable shall be used for main backbone cable and/ or lateral cables that connect to traffic signal and/ or communications cabinets. The main backbone cable shall be terminated as shown on the project plans.

Splicing shall be conducted at cable end splice locations and device splice locations shown on the project plans or 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

6
Revision of Section 614
Fiber Optic Cable (Single Mode)

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 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 as shown on the project plans. If cable end splices are not shown on the project plans, 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:

(a) Under max pulling tension – 20 (Twenty times the cable outside diameter)
(b) 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.

7
Revision of Section 614
Fiber Optic Cable (Single Mode)

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. Spare pull tape and tracer wire shall remain in conduits after the installation of fiber for locating purposes and for future cable installations. Splicing of the pull tape and tracer wire, for continuity purposes, shall conform to the requirements of the pull tape manufacturer.

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.

8
Revision of Section 614
Fiber Optic Cable (Single Mode)

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 achieve 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 and communications cabinet. The label shall be provided with information as shown on the Plans.

The Contractor shall coil a minimum of 50 feet of each fiber cable in pull boxes and 100 feet in manholes, where splicing will occur as part of this project or is expected to occur in the future.

Backbone and lateral buffer tubes and fiber strands shall be labeled on the splice tray prior to sealing of the closure or splice tray in the fiber optic termination panel. 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 (12 Fiber).

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.

Subsection 614.13 shall include the following:

Fiber Optic Cable shall include backbone and lateral cable and shall include all labor and materials required to install the cable to make a complete and operational system and shall include the following items:

(a) All associated materials, including pull tape and tracer wire.
(b) Identification labels for both backbone and lateral fiber cables in each pull box, manhole, communications cabinet and network facility
(c) As Built Documentation

9
Revision of Section 614
Fiber Optic Cable (Single Mode)

Subsection 614.14 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Fiber Optic Cable (Single Mode) (12 Fiber)	LF

1

Revision of Section 614
Closed Circuit Television Camera (Traffic Surveillance)

Section 614 of the Standard Specifications is hereby revised to include the following:

Subsection 614.01 shall include the following:

This work consists of the installation of a closed-circuit television camera at the locations shown on the plans.

Subsection 614.08 shall include the following:

(m) Closed Circuit Television Camera (Traffic Monitoring)

Closed circuit television camera shall be the Panasonic WV-X6531NS.

The following accessories shall be provided for each IP camera:
Panasonic PAPM4 Pole Mount Bracket
Panasonic PWM20G Gooseneck Black
Transformer Altronix T2428100 24 VAC.
Veracity VOR-OS Outsource Midspan 15/20W POE 802.3AF Injector – 1 port

Subsection 614.10 shall include the following:

The closed-circuit television camera shall be installed in accordance with the details shown in the plans and in accordance with manufacturer's recommendations. The Contractor shall deliver the camera and accessories to the City and County of Denver's Traffic Operations Department at 5440 Roslyn, Denver, Colorado at least 4 weeks prior to installation for the camera calibration and set up. The Contractor shall pick up the camera and shall install it at the proper location. The Contractor shall make arrangements for a City and County of Denver Traffic Operations' representative to be on-site to ensure proper installation.

Subsection 614.13 shall include the following:

Closed circuit television cameras will be measured by the actual number of closed circuit television cameras that are installed and accepted. All accessories shall not be measured separately.

Subsection 614.14 shall include the following:

Pay Item	Pay Unit
Closed Circuit Television Camera (Traffic Surveillance)	Each

2

Revision of Section 614
Closed Circuit Television Camera (Traffic Surveillance)

Payment will be full compensation for all work, materials, and equipment required to install a fully operational CCTV in accordance with these specifications.

1

Revision of Section 614
Test Fiber Optic Cable

Section 614 of the Standard Specifications is hereby revised for this project to include the following:

Subsection 614.01 shall include the following:

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.

Subsection 614.08 shall include the following:

The Contractor shall use equipment that is calibrated biennially. 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.

Subsection 614.10 shall include the following:

Prior to splicing and testing on the project the Contractor shall submit a detailed Method Statement to the Project Engineer describing the splicing plan and testing schedule and methods. No fiber optic splicing shall begin until the Method Statement is submitted and approved. Once the splicing and testing begins, the Method Statement shall be updated if necessary, to address any required changes in the original planned and approved procedures.

The contractor shall conduct fiber optic testing at the following stages:

2

Revision of Section 614
Test Fiber Optic Cable

(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
(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.

The Contractor shall document bare fiber slack not accounted for in jacket length.

3
Revision of Section 614
Test Fiber Optic Cable

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 traffic management system 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.

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.

4
Revision of Section 614
Test Fiber Optic Cable

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

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

Acceptable Attenuation Values

5
Revision of Section 614
Test Fiber Optic Cable

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

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 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 traffic management system building) to the far end of the sub-ring (next traffic management system 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.

6
Revision of Section 614
Test Fiber Optic Cable

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 at both the communications termination panel and the communications 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 City of Centennial personnel along with Ciena network engineers will configure the fiber into the overall Centennial signal network. If network communications cannot be achieved, a review of the CWDM testing materials will be begin.

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.

Submittals

7
Revision of Section 614
Test Fiber Optic Cable

The Contractor shall submit test result documentation as an electronic copy.
After each reel test, the Contractor shall submit one electronic copy of the OTDR trace for every fiber on the reel.

After installation, the Contractor shall submit 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 traffic management system buildings.

The Contractor shall submit electronic copy 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

Subsection 614.13 shall include the following:

Testing of fiber optic cable will be measured by all fiber optic testing, retesting, including all labor, materials, and document submittals necessary to complete the work.

Subsection 614.14 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Test Fiber Optic Cable	Lump Sum

Payment will be full compensation for all labor, materials and equipment required to complete the work.

1

Revision of Section 614
Ethernet Managed Switch

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work consists of the installation of an Ethernet Managed Field Switch in the CCD controller cabinets. The Contractor shall furnish and install the switch within the Traffic Signal Cabinet as an integral part of the Traffic Signal Controller and Cabinet Assembly.

Subsection 614.08 shall include the following:

The Ethernet Managed Field Switch installation is hereby added to the Special Provision and the Ethernet Switch shall comply with the following specifications:

General System Requirements –The Ethernet Managed Field Switch shall be one that is currently stocked by the City and County of Denver or approved equal. The current Ethernet Managed Field Switch that is stocked by the City and County of Denver is the Hirschmann Managed Fast/Gigabit Industrial Ethernet Switch and comprises of the following parts:

(1) Quantity 1 – "OpenRAIL Switch Power – Managed Fast/Gigabit Industrial Ethernet Switch, Fanless Design, Power over Ethernet (PoE+) Support with up to 24 Ports and 120 Watt, 24x10/100 Mbit/s Ethernet Ports, 4x 10/100/1000 Mbit/s Ethernet Ports, 4x FE/GE Combo Ports"
The OpenRAIL Switch Power currently stocked by the City and County of Denver is the HIRSHMANN RSPE32-24044O7T99-TPPZ999HHSE2AXX.X.XX.

(2) Quantity 4 – "SFP Fiberoptic Gigabit Ethernet Transceiver, Extended Temperature Range, 1 x 1000BASE-LX with LC Connector, SFP-GIG-LX/LC EEC"
The Gigabit Ethernet Transceiver currently stocked by the City and County of Denver is the HIRSCHMANN 942 196-002.

(3) Quantity 2 – "Empty Module Slot Cover, RSPM".
The Empty Module Slot Cover currently stocked by the City and County of Denver to be sued for the HIRSCHMANN RSPE32-24044O7T99-TPPZ999HHSE2AXX.X.XX OpenRAIL Switch Power is the HIRSCHMANN 942131001 RSPM-COVER.

(4) Quantity 1 – "48VDC Rail Power Supply"
The 48 VDC Rail Power Supply currently stocked by the City and County of Denver to be used with the HIRSCHMANN RSPE32-24044O7T99-TPPZ999HHSE2AXX.X. OpenRAIL Switch Power is the BELDEN 942 200-001, "RPS 260/PoE EEC.

2

Revision of Section 614
Ethernet Managed Switch

Test Requirements – Contractor shall supply one unit of Ethernet Managed Field Switch to the Engineer for specification compliance testing and approval. If the product passes the compliance test and evaluation, the Contractor will be notified to complete the order. If the product does not pass the specification compliance testing and approval evaluation by CCD-PW Transportation, the unit will be returned to the Contractor. The Contractor shall supply other units until satisfactory test results are achieved.

Subsection 614.13 shall include the following:

The unit price for furnish and install of the Ethernet Managed Switch shall be for a complete system and successful operation of the item. The Ethernet Managed Switch installation will be tested in accordance with this specification or as directed by the Engineer. Installation shall include all wiring for hook-up, related labor, material, and all necessary documentation of testing.

Subsection 614.14 shall include the following:

Pay Item	Pay Unit
Ethernet Managed Switch	Each

1

Revision of Section 614
Grounding and Bonding

Section 614 of the Standard Specifications is hereby revised for this project as follows:

Subsection 614.01 shall include the following:

This work consists of grounding and bonding requirements at project locations for all traffic signal and Intelligent Transportation System (ITS)-related structures, poles, service pedestals, and cabinets.

Subsection 614.08 shall include the following:

(a) Applicable Documents. Materials furnished and work performed in this section shall comply with the most current edition of the following codes and/ or standards. Identify to the Engineer any conflicts between the requirements of codes/standards development organizations and the plans and specifications for this project.
   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
   10. UL 467 – Grounding and Bonding Equipment

(b) Grounding electrodes (driven rods). Provide ground rods that meet or exceed the following requirements:
   1. 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.
   2. 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, but must be approved by the Engineer in writing.

(c) Grounding Electrode Conductor. The grounding electrode conductor shall be a stranded copper with a minimum size of #4 AWG, unless otherwise specified.

2
Revision of Section 614
Grounding and Bonding

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. 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).

(d) 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.

(e) Ground Bus. Provide copper bar stock grounding busbar as shown on plans. If the dimensions of the busbar are not shown on the plans, 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.

Subsection 614.10 shall include the following:

(a) 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.

3
Revision of Section 614
Grounding and Bonding

A. Install one grounding electrode. Each ground rod shall be installed such that at least eight (8) feet of 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 Centennial's 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 and a 3- point fall-of-potential method
D. The resistance to earth of the ground rod shall be less than 10 ohms. If the results equal or exceed 10 ohms, the Contractor install a second grounding electrode a minimum of one electrode length away from the first grounding electrode. All direct buried bonding jumpers used to connect grounding electrodes shall be a bare copper conductor not smaller than 2 AWG. All other bonding jumper types used to connect grounding electrodes shall be installed and sized in accordance with Article 250.53(C) of the NEC. Additional grounding electrodes shall be added to the grounding electrode system until the ground resistance test is less than 10 ohms.
E. Record and report results to Engineer in writing. Centennial's target resistance to ground shall be less than 10 Ω. 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 Centennial.
F. 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,

4
Revision of Section 614
Grounding and Bonding

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 galvanization, 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

5
Revision of Section 614
Grounding and Bonding

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.

4. Testing.
   A. Testing shall be performed prior to connecting to utility ground in an effort to eliminate ground loops.
   B. 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. Provide documentation to the Engineer of ground grid measurement results for each ITS site location tied to a single grounding system.
   C. 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.

(b) Submittals.

1. Provide cut-sheets of each type of product proposed for approval by the Engineer prior to commencement of work.

6
Revision of Section 614
Grounding and Bonding

2. Provide a system plan, conductor routing, supports, connectors and ground rods along with connection, mounting and splicing details.

Subsection 614.13 shall include the following:

Grounding and bonding will not be measured or paid for separately but will be considered subsidiary to the field device, structure, pole, service pedestal, and cabinet items, and shall include all labor, materials, equipment, testing, and documentation required to complete the work.

Subsection 614.14 shall include the following:

Grounding and bonding will not be paid for separately but will be considered subsidiary to the structure, pole, service pedestal and cabinet items, and shall include all labor, materials, equipment, testing and documentation required to complete the work. The work covered in this section consists of labor, materials, and services required for a functional and unobtrusive grounding system.

Revision of Section 623
Irrigation System

Section 623 of the Standard Specifications is revised as follows:

Subsection 623.01 is revised to include the following:

Irrigation systems within twelve (12) inches of the reconstruction areas which are damaged as a result of the reconstruction activity will be repaired and paid for. Irrigation systems beyond this limit which are damaged by the Contractor will be repaired by the Contractor at no expense to the City.

Subsection 623.33 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Relay Sprinkler System	Lump Sum

1

Revision of Section 625 Construction Surveying

Section 625 of the standard specifications is hereby revised as follows:

Delete section 625 and replace with the following:

DESCRIPTION

625.01 This work consists of the construction surveying, calculating, and staking, including ROW limits, necessary for the construction of all elements of the project. The work shall be done under the supervision of a Professional Land Surveyor (PLS) who is licensed in the State of Colorado. Locating, preserving, referencing, installing and restoring land monuments such as Primary Control monuments from which the Right of Way or any land boundary will be calculated, described or monumented, Public Land Survey System (PLSS) monuments, General Land Office (GLO) monuments, Bureau of Land Management (BLM) monuments, Mineral Survey (MS) monuments, Right of Way (ROW) monuments, property boundary monuments and offsets, Range Points, benchmarks, easement monuments, and other monuments that are required by law or regulation to be established by a PLS, and the determination of any land boundary, shall be done under the supervision of a Professional Land Surveyor (PLS) who is licensed in the State of Colorado.

MATERIALS AND EQUIPMENT

625.02 The Contractor shall furnish all personnel, survey equipment, safety equipment, materials, and traffic control necessary to perform the required construction surveying and staking. All surveying equipment, including Electronic Distance Meters (EDM), total stations, theodolites, levels, rods, tapes, tripods, tribrachs, and Global Positioning System (GPS) receivers and equipment.

If any survey equipment is found to be functioning outside the manufacturer's specified tolerance, certification from an approved repair facility showing that the instruments have been repaired, properly adjusted, or both if necessary shall be included in the survey records and submitted to the City Surveyor's Office before being used.

CONSTRUCTION REQUIREMENTS

625.03 The Contractor shall check and verify all established Primary horizontal and vertical control points.

All survey records generated shall be the property of the City and shall be available to the City Surveyor's Office for inspection or reproduction at all times. All survey records shall be transmitted to the City Surveyor's Office for inclusion into the project records before final project acceptance.

2
Revision of Section 625
Construction Surveying

Electronic formats may be acceptable, please coordinate with the City Surveyor's Office. Copies of any new Monument Records filed by the PLS with the State Board of Registration shall be submitted to the City Surveyor prior to filing.

625.04 Contractor Surveying. The Contractor's PLS shall perform all construction surveying and staking that is necessary for construction of the project.

625.05 Staking. It is the responsibility of the Contractor's PLS to adhere to industry standards and acceptable practices in regard to staking. Any restaking will be the responsibility of the Contractor's PLS at no cost to the City.

625.06 Accuracy and Tolerances. It is the responsibility of the Contractor's PLS to adhere to industry standards and applicable standards with regard to horizontal and vertical accuracy tolerances.

625.07 Responsibility and Inspection. Supervision and coordination of construction surveying and staking is the Contractor's responsibility. The City Surveyor's Office or Engineer may inspect the Contractor's surveying; however, such inspection will not relieve the Contractor of any responsibility for accuracy or completeness of work. All Contractor surveying inaccuracies, errors, or omissions shall be corrected at the Contractor's expense.

625.08 Reset Monuments and Stakes. Survey monuments, benchmarks, and other significant stakes that are damaged, destroyed, or made inaccessible by the progress of construction shall be replaced, transferred or reestablished at the Contractor's expense.

Locating, preserving, referencing, installing and restoring land monuments as described in 625.01, shall be done in accordance with Section 629, under the supervision of a PLS who is experienced and competent in Right of Way and boundary surveying and licensed in the State of Colorado.

629.09 Changes. All changes in lines and grades required by field conditions and all discrepancies in grades, alignment, location or dimensions detected by the Contractor shall be immediately submitted to the Engineer in writing. No changes in given data or plans will be allowed unless approved by the Engineer in writing. All changes shall be documented by the contractor.

629.10 Pay Quantities Measurements. The Engineer will perform all interim and final measurements deemed necessary by the City to determine contract pay quantities. The Contractor shall establish and maintain Control points and stationing as required for these measurements.

3
Revision of Section 625
Construction Surveying

629.11 Survey Records. Survey records shall be completed as the work is done. Field survey notes for construction surveying and checking by the Contractor shall be recorded in survey records in conformance with industry standards and acceptable practices.

All survey records generated shall be the property of the City and shall be available to the City Surveyor's Office or the Engineer for inspection or reproduction at all times. All survey records shall be transmitted to the City Surveyor's Office for inclusion into the project records before final project acceptance. All survey records shall be stamped with the seal of, and signed by, the responsible PLS.

Electronic submittal of survey records may be acceptable, please coordinate with the City Surveyor's Office.

METHOD OF MEASUREMENT

625.12 Construction surveying will not be measured but will be paid for on a lump sum basis.

BASIS OF PAYMENT

625.13 Payment for construction surveying will be the lump sum bid and will be full compensation for all surveying work necessary to complete the project to include all resetting of stakes, marks, monuments and preparing survey documentation as required.

Partial payment for construction surveying, as determined by the Engineer, will be made as the work progresses.

Payment will be made under:

Pay Item	Pay Unit
Construction Surveying	Lump Sum

Revision of Section 626
Mobilization

Subsection 626 of the standard specifications is hereby revised as follows:

Subsection 626.01 is hereby revised to include:

This item also includes demobilization of equipment and supplies from this project site.

Subsection 626.02 is hereby deleted and replaced by the following:

Two payments will be made for the mobilization item. 50% of the amount bid for mobilization will be paid at the completion of mobilization. The remaining 50% of the amount bid for mobilization will be paid at the completion of the project when the equipment has been demobilized.

Pay Item	Pay Unit
Mobilization	Lump Sum

Revision of Section 627
Pavement Marking

Section 627 of the Standard Specifications is revised as follows:

Subsection 627.01 is revised to include the following:

The Contractor is responsible for installation and removal of temporary pavement marking. The Contractor shall coordinate the work of the striping, including traffic control devices and flaggers.

Subsection 627.03 is revised to include the following:

The Contractor shall replace permanent pavement markings damaged or removed as a result of the work. Pavement marking material shall be new material of the same type which existed prior to the work commencing.

Subsection 627.11 is revised as follows:

Installation and removal of temporary pavement marking will not be measured and paid for separately but shall be included in the cost of Item 630 Construction Traffic Control.

Replacing permanent paving marking damaged or removed as a result of the work will not be measured and paid for separately.

1

Revision of Section 629
Survey Monumentation

Section 629 of the Standard Specifications is hereby deleted and replaced with the following:

DESCRIPTION

629.01 This work consists of locating, preserving, referencing, installing and restoring the following types of land monuments by a Colorado-licensed Professional Land Surveyor (PLS). The following types of monuments, if required, shall be considered included: Primary Control monuments from which Right of Way (ROW) or any land boundary will be calculated, described or monumented; Public Land Survey System (PLSS) monuments; General Land Office (GLO) monuments; Bureau of Land Management (BLM) monuments; Mineral Survey (MS) monuments; ROW monuments; property boundary monuments; and offsets, City of Denver range points, benchmarks, easement monuments, and other monuments that are required by law or regulation to be established by a PLS, along with installing or adjusting Monument Boxes.

The production of additional documentation may be required by the City Surveyor's Office. All such work included in this section shall be performed under the supervision of a Colorado- licensed PLS.

MATERIALS AND EQUIPMENT

629.02 The Contractor shall furnish all personnel, survey equipment, safety equipment, materials and traffic control necessary to perform the required Monumentation and related surveying.

CONSTRUCTION REQUIREMENTS

629.03 A construction survey conference shall be held with the City Surveyor's Office prior to performing any surveying work under this section. The Contractor's Surveyor (PLS) and party Chief shall attend. A construction survey checklist shall be completed and signed by the City Surveyor's Office and the Contractor.

The Contractor shall check and verify all established primary horizontal and vertical control points.

All survey records generated shall be the property of the City & County of Denver and shall be available to the City Surveyor's Office for inspection or reproduction at all times. All survey records shall be transmitted to the City Surveyor's Office for inclusion into the project records before final project acceptance.

2
Revision of Section 629
Survey Monumentation

Electronic formats may be acceptable; please coordinate with the City Surveyor's Office.

Copies of any new Monument Records filed by the PLS with the State Board of Registration shall be submitted to the City Surveyor prior to filing.

629.04 Locating Monuments – This work consists of field locating all survey Monumentation as discussed in 629.01 which is in place within the project limits. A diligent search of construction zones and project limits shall be performed by the PLS.

629.05 Preserving and Referencing Monuments – All monuments as described in 629.01 shall be preserved, referenced and reset by a PLS within the project limits.

629.05 Installing Monuments – All monuments described in 629.01 shall be preserved throughout construction. If any monuments as described in 629.01 are to be disturbed or removed during construction, it will be the responsibility of the Contractor's PLS to reset all monuments to current City & County of Denver standards. Appropriate documentation will be required for all reset monuments.

629.06 Monument Box – If required, this work shall consist of installing or adjusting monument boxes to current City or CDOT requirements including the CCD Range Point boxes.

METHOD OF MEASUREMENT

629.07 Survey monuments, monument boxes and adjustment of monument boxes will be measured by the actual number of the various types installed and accepted by the Engineer. Measurement for locating survey monuments, preserving and referencing monuments will not be measured and paid for separately.

BASIS OF PAYMENT

629.08 The accepted items and quantities will be paid for at the contract unit price per each. Approval of the Engineer is required prior to undertaking any work identified as part of this Section.

Payment will be made under:

Pay Item	Pay Unit
Survey Monument (Type 1)	Each

3
Revision of Section 629
Survey Monumentation

Prior to payment, all survey records and documentation must be submitted and accepted by the City Surveyor's Office.

The construction survey checklist, equipment calibrations and survey records will not be paid for separately but shall be included in the work. The locating of monuments, and preserving and referencing monuments will not be paid for separately but shall be included in the work.

Revision of Section 630
Uniformed Traffic Control

Section 630 of the Standard Specifications is hereby revised for this project as follows:

Subsection 630.09 shall include the following:

Uniformed Officers - The Contractor shall employ off-duty police officers to provide traffic control and traffic enforcement throughout the project as required by the Project Manager. Authorization must be made by the Project Manager in advance of working arrangements for Uniformed Traffic Control. Arrangements for officers shall be made at least 2 weeks in advance by contacting the following police agency:

Denver Police Department Office of Secondary Employment

Phone Number: (720) 337-0775; Email: Analisa.ortiz@denvergov.org

The Denver Police Department Office of Secondary Employment will require 48 hours notice.

Subsection 630.17 shall include the following:

Uniformed Traffic Control will be measured by the actual number of hours that Uniformed Traffic Control is active for the project.

Subsection 630.18 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Uniformed Traffic Control	Hour

1

Revision of Section 630
Construction Traffic Control

Section 630 of the Standard Specifications is hereby revised as follows:

Subsection 630.01 shall be revised to include the following:

The Contractor shall submit, in writing, the proposed Method of Handling Traffic (MHT) for review and approval of the Project Engineer. The MHT shall be developed according to this section and the construction plans.

Subsection 630.05 Traffic Cones shall include the following:

Steel drum channelizing devices shall not be used for traffic control

Subsection 630.06 Channelizing Devise (fixed) shall include the following:

Non-metallic drums or tubular markers may be substituted for vertical panel channelizing devices.

Subsection 630.09 General shall include the following:

The flagger's STOP/SLOW sign paddle shall be 18 inches with letters six inches high.

Subsection 630.10(a), shall include the following:

When a different MHT is required for a subsequent construction phase, it must be submitted at least two weeks prior to starting that phase. All proposed methods of handling traffic shall be approved, in writing, by the Project Engineer following approval of the Traffic Engineering Services Department.

Approval of the proposed MHT does not relieve the Contractor of liability specifically assigned to him under the contract. The Contractor shall erect and maintain warning lights, signs, barricades, and sufficient safeguards around all excavations, embankments, and obstructions.

The contractor shall notify the Project Engineer by Thursday at 3:00 P.M. which streets they intend to work on the following week. This notification will be made for all phases of construction.

Subsection 630.10(a)(1) shall be added as follows:

The key elements of the Contractor’s method of handling traffic (MHT) are outlined in subsection 630.10(a).

2
Revision of Section 630
Construction Traffic Control

The components of the Traffic Control Plan (TCP) for this project are included in the following:

- Subsection 104.04 and Section 630 of the Standard Specifications.
- Tabulation of Traffic Engineering Items included in the plans for this project.
- Latest revised Standard Plan S-630-1, Traffic Controls for Highway Construction and Standard Plan S-630-2.

Special Traffic Control Plan requirements for this project are as follows:

1. During the construction of this project, traffic shall use the present traveled roadway.

2. Work that interferes with traffic will only be permitted during the following hours:
   - The Contractor shall perform all the work on the roadway between the hours of 8:30 AM and 3:30 PM or as approved by the Project Engineer. Weekend and nighttime work will be allowed with the prior written approval of the Project Engineer. During this time, only one lane can closed on each approach.
   - Work will not be permitted that directly or indirectly interferes with the flow of traffic between the hours of 5:30 AM and 8:30 AM Monday through Friday; between the hours of 3:30 PM to 6:30 PM Monday through Thursday; and after 2:00 PM on Fridays unless otherwise authorized by the Project Engineer.
   - No work on Holidays
   - Contractor shall not close lanes during special events.
   - Contractor shall coordinate lane closures with adjacent projects.
   - Contractor shall maintain business access during business hours.
   - The Contractor shall coordinate all of the work on the roadway during any special event with the City and County of Denver.

3. The Contractor shall install construction traffic control devices where they do not block or impede other existing traffic control devices or sidewalks for pedestrians, disabled persons or bicyclists. The Contractor is restricted from storing any materials, construction traffic control devices, signs, etc. in any median area or park area.

4. Vertical cuts or fills greater than 1 inch resulting from construction operations adjacent to traffic lanes, or within the clear zone shall be temporarily sloped at a 6:1 or flatter slope, and delineated at 35 foot intervals immediately after removal operations to safeguard the traveling public.

3
Revision of Section 630
Construction Traffic Control

5. Construction equipment used on this project shall meet the same minimum exhaust requirements as those specified by the manufacturer of the equipment.

6. The Contractor and subcontractors shall equip their construction vehicles with flashing amber lights. Equipment to be used at night shall also be equipped with flashing amber lights. Flashing amber lights on vehicles and equipment shall be visible from all directions.

7. The Contractor shall maintain access to all roadways, side streets, walkways, alleyways, driveways, and hike/bike paths at all times unless otherwise directed by the Engineer. Parking areas temporarily disturbed by construction activities shall be restored to a useable condition during non-working hours. Such temporary parking shall utilize an all weather surface. The Contractor shall develop an Access Maintenance Plan in coordination with, and based on the requirements of, the affected property owners and tenants, and submit it to the Engineer for approval prior to commencement of work. This plan shall detail all barricades, ramps, signs, and temporary means of access required by the property owners or tenants. Prior to commencing any work which affects access to a property, the Access Maintenance Plan for that property must be submitted and approved by the Engineer.

8. The Access Maintenance Plan shall be coordinated with all affected owners and tenants. The Access Maintenance Plan shall include documentation of this coordination, including the approval signature of each affected owner or tenant.

   Should the Contractor be unable to obtain approval and signatures, documentation of the efforts made to obtain said approval and signatures must be submitted.

   All access shall be maintained on surfaces equal to or better than those existing at the time the access is first disturbed. For short periods of time only as allowed by the Engineer, access may be maintained on an aggregate base course surfaces.

9. The Contractor shall maintain continuous access throughout the project for pedestrians, bicyclists, and disabled persons. When the existing access route is disturbed by construction, a temporary all-weather access shall be provided. All temporary access shall be a minimum of 5 feet wide and meet Americans with Disabilities Act (ADA) requirements. Acceptable all weather surfacing shall be concrete or asphalt surface, or as approved by the Engineer. Delineation of pedestrian access through the work area shall be accomplished using temporary plastic fencing.

4
Revision of Section 630
Construction Traffic Control

10. The costs of maintaining access will not be paid for separately unless otherwise provided, but shall be included in the work. Utilization of materials to be incorporated into the work may be permitted. However, any degradation or other contamination or destruction shall be corrected at the Contractor's expense prior to acceptance.

11. During non-construction periods (evenings, weekends, holidays, etc.) all work shall be adequately protected to insure the safety of vehicular and pedestrian traffic, as detailed in the Contractor's MHT. Excavations or holes shall be filled in or fenced when unattended.

12. Whenever the Contractor removes, obliterates, or overlays any pavement markings, he /she shall replace them on a daily basis prior to opening the affected areas to traffic. All temporary pavement markings shall fully comply with the Standard Specifications and Special Provisions.

13. The Contractor shall not have construction equipment or materials in the lanes open to traffic any time unless directed by the Engineer.

14. All personal vehicle and construction equipment parking is prohibited where it conflicts with safety, access, or the flow of traffic. Landscaped areas, public park areas, and roadway shoulders shall be kept clear of parking and storage of all personal and construction equipment except where approved by the Engineer.

15. The Contractor shall not place tack coat on any surface to be paved where traffic will be forced to travel upon fresh bituminous materials.

16. The Contractor shall be required to make arrangements with the Regional Transportation District (RTD) prior to closing any existing bus stops within the project limits. Temporary stops will be required as directed by the Engineer and as required by RTD. For bus stop/route conflicts Regional Transportation District, RTD / 1560 Broadway, Suite 700, Denver, CO 80202 shall be contacted two business days prior to start of construction.

17. The Contractor shall be required to maintain temporary drives at any existing establishment that has singular access off of the roadways, unless otherwise approved in writing by the property owner.

18. No work that interferes with traffic will be allowed on holidays or any day of a three-day or four-day weekend that includes a holiday. Holidays on which this restriction

5
Revision of Section 630
Construction Traffic Control

applies consist of those holidays recognized by the State of Colorado as listed in subsection 101.36

19. All lane closures shall be subject to the approval of the Engineer. Request for each closure shall be made at least 24 hours in advance of the time the lane closure is to be implemented. Lane closures will not be allowed to remain unless being utilized in continuum for the intended purpose for which they were set up.

20. During no-working hours, the roadways shall be restored to a safe travel conditions for the free flow of traffic. Any maintenance required restoring the roadways to this condition, including the pavement patching and grading, shall be done prior to opening the areas to traffic or completing work for the day.

21. The Contractor shall clean the roadway of all construction debris before opening it to traffic.

22. All flagging stations used at night shall be illuminated with floodlights. Street, highway lights and “high mast lighting” may be used for flagging station illumination when approved by the Engineer. Floodlights shall be located and directed so as not to interfere with the sight of any motorists, and the cost to be included in the work.

23. Prior to removal and resetting of any sign the Contractor and Engineer shall prepare an inventory. Any signs damaged due to the Contractor’s operations shall be replaced in kind or repaired by the Contractor at no additional cost to the project.

24. Unless noted otherwise, all costs incidental to the foregoing requirements shall be included in the original contract prices for the project, including any additional traffic control items required for haul routes into the project.

25. The Contractor shall limit construction activities and equipment to one side of the road at a time, unless otherwise approved by the Engineer. Temporary lane closures shall be limited to a single lane in one direction for roads with multiple lanes in a given direction.

26. The Contractor shall reference DOTI Permit 116: Traffic Control Procedures for general traffic control procedures for street/public occupancy permits.

27. The Contractor shall reference DOTI Rules and Regulations 22.3 Pertaining to the Issuance of Permits by the City Traffic Engineer for City permitting requirements.

6
Revision of Section 630
Construction Traffic Control

Subsection 630.10 (a) (10) shall be added as follows:

Number of hours for uniformed traffic control shall be tabulated for submittal.

Subsection 630.10 (a) (11) shall be added as follows:

Contractor shall obtain all required access and construction permits from the City & County of Denver prior to initiating work along City right of way.

All lane closures require an arrow board to be installed.

All streets that will be reduced in the number of travel lanes should have variable message boards installed for a minimum of 3 days after the striping change to inform drivers of the lane reduction.

Subsection 630.15 is hereby deleted and replaced with the following:

The Contractor shall furnish all other personnel – including flaggers, traffic control inspector, and traffic control supervisor - and other materials necessary to perform the Construction Traffic Control as required and these quantities will not be measured but will be included in the cost of Construction Traffic Control.

Temporary pavement markings for traffic control will not be measured and paid for separately but shall be included in the work.

Subsection 630.16 is hereby deleted and replaced with the following:

All traffic control shall comply with the requirements of the FHWA MUTCD Part 6 (2011 edition) – Temporary Traffic Control.

Subsection 630.18 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Construction Traffic Control	Lump Sum

All costs incidental to maintenance of access will not be paid for separately but shall be included in the work.

7
Revision of Section 630
Construction Traffic Control

All costs incidental to the foregoing requirements shall be included in the original contract prices for the project.

Allowance Items

DESCRIPTION

This Special Provision contains the City and County of Denver's estimate for Allowance Items included in the Contract. The estimated amounts will be added to the total bid to determine the amount of the performance and payment bonds.

BASIS OF PAYMENT

Payment will be made in accordance with Subsection 109.04. Payment will constitute full compensation for all work necessary to complete the item.

Allowance Item	Pay Unit	Estimated Amount
AW Landscaping	AW	$10,000
AW Erosion Control	AW	$8,000
AW Environmental Health and Safety Management	AW	$5,000

Allowance descriptions include:

Landscaping – This work is for restoring existing landscape, including topsoil sod, and irrigation systems back to preconstruction condition.

Erosion Control – This work consists of stormwater BMPs authorized and approved by the Engineer. This Force Account is to pay for all necessary work and materials for erosion control items not identified in the plans and at the Engineer's direction. Payment will be made based on time and materials used to perform the work. All items shall be pre-approved by the engineer prior to installation or they will be at no cost to the project.

Environmental Health and Safety Management – This work is described in Section 250 – Environmental, Health, and Safety Management of the Standard Specifications.

Special Construction Requirements
Traffic Signal Installation Personnel Requirement

The Contractor shall adhere to the following requirements regarding Traffic Signal construction and maintenance personnel. Current Certificates showing qualifications shall be submitted at the pre- construction meeting.

(1) For any work inside the traffic signal cabinet, Signal and Signal Bench Technician shall be minimum IMSA Level II certified. This includes the completion of training in construction, corrective maintenance, and signal turn-on.
(2) For all work external to the signal cabinet, a minimum IMSA Level I Traffic Signal Field Technician/Electrician or Traffic Signal Bench Technician/Signal Technician is required. An IMSA Level II Traffic Signal Electrician shall be on the job site at all times that signalization work is taking place to ensure proper construction. A maximum ratio of four IMSA Level I to one IMSA Level II will be allowed for work external to the signal cabinet.

The United States Department of Labor – Bureau of Apprenticeship and Training may be substituted for the IMSA Level I Traffic Signal Electrician requirement.

1
Utilities

The known utilities within the limits of this project are:

UTILITY COMPANY ADDRESS	CONTACT NAME EMAIL	PHONE/FAX
City and County of Denver DOTI – Fiber Optic	Joshua Jones Joshua.jones2@denvergov.org	720-337-2923
Denver Parks and Recreation	Jennifer Cervera – jennifer.cervera@denvergov.org	720-527-0052
Denver Water Department – Water 1600 W 12th Ave Denver, CO 80204	Paul Peloquin Paul.peloquin@denverwater.org	303-628-6620
Lumen – Fiber Optic 5325 Zuni St. Denver, CO 80221	Ben Hoselton - Ben.Hoselton@lumen.com Robert Davis - rdavis@congruex.com	303-241-8919 720-854-4341
Xcel Energy – Electric & Gas 1800 Larimer St Denver, CO 80202	(to be updated prior to advertisement)	--
Zayo Group – Fiber Optic 1805 29th Street, Suite 2050 Boulder, CO 80301 Zayo Locate Contractor- Stake Center Locating, Inc	Chris Gates Chris.Gates@cobbfendley.com Zayo.relo.colorado@zayo.com	720-351-6420 800-961-6500

The work described in these plans and specifications will require full cooperation between the Contractor and the utility companies, in accordance with Subsection 105.11, in conducting their respective operations so the utility work can be completed with minimum delay to all parties concerned.

All new underground facilities, including laterals up to the structure or building being served, installed as part of this project must be electronically locatable when installed, in compliance with Colorado Revised Statutes, Title 9, Article 1.5.

PART 1 — CONTRACTOR SHALL PERFORM THE WORK LISTED BELOW:

For utility adjustments by others that are anticipated to be performed during construction:
Coordinate project construction with performance by the utility owner of each utility work element anticipated to occur during construction listed in Part 2 below. Provide an accurate construction schedule that includes all utility work elements to the owner of each impacted utility. Conduct necessary utility coordination meetings, and provide other necessary accommodations as directed by the Engineer. Notify each utility owner in writing, with a copy to the Engineer, a minimum of two (2) weeks prior to the time each utility work element is to be performed by the utility owner to meet the project schedule.

2
Utilities

The Contractor is responsible for coordinating and working alongside each utility owner to comply with their respective permit requirements, as applicable, including traffic control.

Perform each utility work element for every utility owner listed below. Notify each utility owner in advance of any work being done by the Contractor to and near its facility, so that the utility owner can coordinate its inspections for final acceptance of the work with the Engineer. Obtain written acceptance from the utility owner for work performed by Contractor.

The Contractor shall remove all abandoned utility facilities as necessary to accommodate construction and shall not be paid for separately but shall be included in the work unless otherwise specified in the plans.

Project Limits – All Utility Owners
The Contractor shall contact each utility company via the standard 811 notification system a minimum of two (2) business days, unless otherwise noted, prior to working in the vicinity of the utility company's facilities so that each utility company can coordinate any needed locates, adjustments or inspections.

Prior to excavating, the Contractor shall positively locate (through potholing if necessary) all potential conflicts with existing underground utilities and proposed construction, as determined by the Contractor according to proposed methods and schedule of construction. The Contractor shall modify construction plans to avoid existing underground facilities as needed, and as approved by the Engineer. Please note that Colorado 811 (formerly Utility Notification Center of Colorado (UNCC)) marks only its members' facilities. Other facilities, such as ditches and drainage pipes may exist, and it is the Contractor's responsibility to investigate, locate and avoid such facilities.

To the extent practicable, the Contractor shall endeavor to achieve the vertical clearance specified by the utility owner when crossing their facilities. A minimum vertical clearance of 18 inches should be maintained between crossing utilities where feasible.

If a need for utility work by either the Contractor or a utility company arises, the following shall apply:

> The Contractor shall be responsible for coordinating the adjustment of utilities on this project. The Contractor shall keep each utility company advised of any work being performed in the vicinity of their facilities, so that each utility company can coordinate any needed locates, adjustments or inspections. The Contractor shall provide the appropriate utility company with ample notice prior to commencing activities in the vicinity of their facilities. The Contractor will work with the affected utilities on the appropriate vertical clearances which shall be maintained wherever feasible. Any

3
Utilities

additional work performed by the Contractor on behalf of the impacted utility company shall not be paid for by the project but shall be paid by the utility company requiring the work, unless otherwise agreed to in writing by the Engineer.

For Xcel Energy Gas and Electric, the following procedure applies:
Existing Xcel Energy Gas and Electric facilities are within the vicinity of the project.

Xcel Electric existing facilities at Martin Luther King Jr Blvd & Kearney St are identified as being impacted by the proposed work and require relocation or adjustment. The Contractor shall protect in place the existing Xcel Electric facilities in the project area during construction, as shown on plans and described below.

- Xcel Energy Electric will perform adjustments to their facilities that are anticipated to be completed prior to construction as described in Part 2. The Contractor is responsible for verifying the work has been completed and protecting in place the new infrastructure.

The Contractor shall install the signal cabinet, controller, associated equipment, and electric meter at each intersection. Following Xcel Energy Electric's installation of the power feed, the Contractor shall complete the connection of power to the signal controller.

Xcel Gas existing facilities are identified as being impacted by the proposed work but should not require relocation or adjustment. The Contractor shall protect in place the existing Xcel Gas facilities in the project area during construction, as shown on plans. The Contractor shall provide 2-ft clearance minimum when crossing existing Xcel Gas lines. If 2-ft clearance cannot be achieved the Contractor will coordinate with Xcel Gas onsite personnel for acceptable clearance.

Timing: In accordance with the Franchise Agreement between Xcel Energy and the City and County of Denver, written notice shall be provided by the City for any relocation or construction work requested of Xcel. Upon receipt of such notice, Xcel shall have a reasonable period, not to exceed ninety (90) days, to complete the requested work, unless otherwise delayed due to unforeseen circumstances or as extended by the City for good cause. The Contractor shall notify Xcel two weeks in advance of initiating work in the vicinity of the Xcel facilities.

For Denver Water facilities, the following applies:
The Contractor shall protect all existing Denver Water facilities in place during construction, unless otherwise noted. Valve adjustments shall be completed as shown on plans. The Contractor shall maintain a minimum of 18 inches of vertical clearance when crossing existing Denver Water facilities. If 18 inches cannot be achieved, the Contractor must

4
Utilities

coordinate with Denver Water to determine acceptable clearance and additional requirements.

Martin Luther King Jr Blvd & Kearney St:

- Denver Water facilities are impacted by the proposed work and require valve adjustments.

Timing: The Contractor shall notify Denver Water two weeks in advance of initiating work in the vicinity of the Denver Water facilities.

For Lumen facilities, the following applies:
Lumen existing facilities at Martin Luther King Jr Blvd & Kearney St are identified as being impacted by the proposed work but should not require relocation or adjustment. The Contractor shall protect in place the existing facilities in the project area during construction, as shown on plans.

Timing: The Contractor shall notify Lumen via the standard 811 notification system at least two business days in advance of initiating work in the vicinity of the Lumen facilities.

For Denver Parks and Recreation (DPR) facilities, the following applies:
DPR existing facilities at the MLK Blvd & Kearney St intersection will be crossed by proposed conduit installations. The Contractor shall work with DPR to ensure construction activity does not impact DPR facilities.

The Contractor shall work with DPR to ensure 12-inch horizontal clearance from proposed signals and construction activity does not impact DPR facilities. If the final signal locations do not meet the 12-inch clearance requirement, field adjustments to the signal location will be required.

The Contractor shall protect in place DPR facilities as shown in the plans.

For Zayo facilities, the following applies:
Zayo existing facilities at Martin Luther King Jr Blvd & Kearney St are identified as being impacted by the proposed work but should not require relocation or adjustment. The Contractor shall protect in place the existing Zayo facilities in the project area during construction.

Timing: The Contractor shall notify Zayo two weeks in advance of initiating work in the vicinity of the Zayo facilities.

5
Utilities

PART 2 — UTILITY OWNERS SHALL PERFORM THE WORK LISTED BELOW:

Utility owners are responsible for obtaining all necessary permits for the City and County of Denver, as required. All utility work, traffic control, and restoration shall be performed in accordance with the latest DOTI Standard Specifications and Details. This work will be performed by the utility owners as necessary to avoid conflicts with construction activities.

Utility owners shall comply with the schedule requirements of the Contractor and make every effort not to impact the overall construction schedule. Unless otherwise approved or directed by the Engineer, abandoned above ground appurtenances such as pedestals shall be removed and abandoned underground utilities and manholes/handholds shall be abandoned in place.

All Utility Owners
Coordinate the support/protection of buried and/ or overhead utilities encountered on-site. This work is expected to be coordinated with construction.

Support the locating and potholing of any potential conflicts with buried utility facilities and proposed construction, and relocate or adjust such facilities, as required. Complete relocation and/ or adjustments of facilities as scheduled with the Contractor. This schedule time shall be determined by the Contractor and Utility Owner. Utility Owner is responsible for coordinating with the Contractor.

Utility owner shall provide standby when construction is near utility owner facilities as required. Utility owners shall coordinate with the Contractor if any facility is found to conflict with the proposed project improvements. If a relocation or adjustment is necessary, utility owners shall schedule and facilitate the work by their own forces and are responsible for coordinating with the Contractor.

Xcel Energy - Gas and Electric:

Xcel Energy shall provide standby when construction is near Xcel facilities for possible relocation and adjustments.

Prior to construction, Xcel Energy Electric will remove one (1) existing Xcel-owned light standard pole within the project limits, and Xcel Energy Electric will reset one (1) existing Xcel-owned light standard pole within the project limits.

Xcel Energy Electric will install a new electrical service power feed to support the proposed traffic signal systems.

6
Utilities

After the Contractor has completed the installation for the traffic signals and luminaires including conduit and wiring to the power source as shown on the plans, Xcel forces shall connect the meter and power source. This work is expected to be coordinated with construction and take one (1) working day at each location to complete.

After the proposed traffic signals are operational, Xcel forces shall disconnect the power to the existing traffic signals. One (1) day after the Contractor has removed all the traffic signal equipment including mast arm, Xcel forces shall disconnect and remove the existing traffic signal pole and luminaires as shown on the plans. This work is expected to be coordinated with construction and take one (1) working day at each location to complete.

Timing: Upon receipt of such notice, Xcel shall have a reasonable period, not to exceed ninety (90) days, to complete the requested work, unless otherwise delayed due to unforeseen circumstances or as extended by the City for good cause. The Contractor shall notify Xcel two weeks in advance of initiating work in the vicinity of the Xcel facilities.

Denver Water:
Denver Water shall inspect utility work performed by the Contractor listed in Part 1 above and provide written acceptance to the Contractor. Denver Water shall coordinate with the Contractor to provide standby when construction is near Denver Water facilities for possible relocation and adjustments.

Timing: Denver Water will coordinate with the Contractor on timing for anticipated adjustments.

Lumen:
Lumen shall coordinate with the Contractor to provide standby as required.

Zayo:
Zayo shall coordinate with the Contractor to provide standby as required.

GENERAL:

The Contractor shall comply with Article 1.5 of Title 9, CRS ("Excavation Requirements") when excavating or grading is planned in the area of underground utility facilities. The Contractor shall notify all affected utilities at least three (3) business days, not including the actual day of notice, prior to commencing such operations. Contact the Utility Notification Center of Colorado (UNCC), at phone no. 811, to have locations of UNCC registered lines marked by member companies. All other underground facilities shall be located by contacting the respective company. Utility service laterals shall also be located prior to beginning excavation or grading.

7
Utilities

Utilities are depicted on these plans in accordance with their achieved “Quality Level” as defined in the American Society of Civil Engineer’s document ASCE 38, “Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data”. Reliance upon this data for risk manage purposes during bidding does not relieve the excavator or utility owner from following all acceptable utility damage prevention statues, policies and/ or procedures during excavation.

The Contractor’s attention is directed to Standard Specifications for Road and Bridge Construction subsection 105.11. No guarantee is made that utility conflicts will be resolved prior to construction activities and any delays resulting from utility relocation work shall be dealt with in accordance with subsection 108.08 of the Standard Specifications for Road and Bridge Construction as amended.

All costs incidental to the foregoing requirements will not be paid for separately but shall be included in the work.

1

Denver (Only) Noise Ordinance
Permit Variance Application Template

Date
Subject: **Request for Variance to Noise Ordinance**
[location where work is to be performed]

Dear Ms. VanDerLoop,

- Name of company/organization seeking the variance
- What is being proposed, where it will occur, expected duration of project
- Brief history regarding proposed project
- Description of the community in the vicinity of the proposed project area

6 (a) Type and Timing of Claim:

- Specific description of proposed project (figures are helpful)
- Why does work need to be conducted at night? (CDOT can provide details to contractor)
- Are there limiting factors preventing this work from being conducted during the day? (CDOT can provide details to contractor)
- Requested variance duration; start and end dates
- Proposed work hours
- Types/categories of equipment being used for the project (if known, a detailed list should be provided as an appendix)
- Is this variance request contingent on other regulatory approvals/permits? (construction, demo, remediation)

6 (b) Date of Payment:

- [The Company's] date of payment is the date shown of this letter/request.

6 (c) Objections to Manager's Determinations:

- Specific items applicant may be in disagreement with concerning Department's recommendations or requirements

6 (d) (1) Hardship if Variance is Not Granted:

- Public safety concerns (CDOT can provide details to contractor)
- Logistical concerns
- Time constraints with a detailed explanation as to why they are necessary
- Cost considerations (specifics desirable)
- Document and evaluate possible alternatives

2

Denver (Only) Noise Ordinance Permit Variance Application Template

6 (d) (2) No Adverse Affects to Public Health:

- List expected noise levels to be generated (1) at the site where work is being performed, and (2) at the nearest sensitive receptor (CDOT can provide details to contractor from Roadway Construction Noise Model)
- Detail existing ambient sound levels (L90, Leq, Lmax) for the same areas (at least 1 night of pre-work monitoring; 9 p.m. to 7 a.m.; two nights (one weekday, one weekend) if work will occur on weekdays and weekends)
- How do the proposed levels compare with existing EPA or other guidance? (CDOT can provide details to contractor)
- Are there adverse health effects other than noise to be concerned with as a result of the proposed work? (CDOT can provide details to contractor)

6(d) (3) Maintain Harmony with the Spirit and Purpose of the Ordinance:
(CDOT can provide details to contractor for sec 6(d) (3)

- Is the scope of work considerate of present and future community concerns?
- How does the scope of work seek to minimize impacts to the community?
- Have noise mitigation techniques been included and/or considered?
- Has a noise monitoring plan been considered or proposed?
- How will community outreach be conducted prior to the start of work?
- Has a community response plan been developed to deal with any future complaints? (contact name and number of on-site representative)

6 (e) Project Location and Haul Routes:

- Figures are preferable (CDOT can provide details to contractor)

6 (f) Petitioner Information
[Company Name and Address]

[Contact Person/Project Manager info]

6 (g) Petitioner's Signature

Sincerely,

[Name and Title]

Note: In addition to this template, CDOT can provide an example of a previously written (City and County of Denver) variance application at the contractor's request.

3
Denver (Only) Noise Ordinance
Permit Variance Application Template

The following field work summary of requirements will be the sole responsibility of the contractor for maintaining compliance with the Denver (only) Permit Variance agreements once granted by the Department of Environmental Health.

1) **Construction Activity Allowable Noise Levels:** Unless the accommodations described in below are provided, construction noise levels shall not exceed:
   a. an hourly Leq of 75 dBA, or 5 dBA greater than an ambient hourly Leq measuring more than 75 dBa, or
   b. an Lmax of 86 dBA during the hours of 9:00 p.m. to 7:00 a.m. (Nighttime Hours)

2) **Hotel accommodations within eligibility zones:** (Contractor) shall make hotel accommodations available for persons residing within eligibility zones where Nighttime construction noise levels exceed allowable noise levels. The eligibility zone shall be determined by a sound study conducted by the (contractor) and approved by DEH prior to a seven-day notification period. During nighttime construction, (contractor) shall conduct noise monitoring to verify the sound study results and shall expand and may restrict the eligibility zone to the areas where the actual noise levels exceed an hourly Leq of 75 dB(A) or an Lmax of 86 dB(A). (Contractor) shall consider any special circumstances brought to their attention regarding individuals in the eligibility zone who cannot utilize hotel vouchers and who may be at risk during this period of time, e.g., residents of 24-hour health care facilities. (Contractor) shall make their best effort to accommodate the needs of such individuals during Construction Activity.

3) **Notifications:** Not less than seven days prior to commencement of construction during Nighttime Hours, (contractor) shall notify individual households located within a 1000 foot radius of the construction, as well as representatives of each affected Registered Neighborhood Organizations. Notice shall be in writing or by direct personal contact from (contractor) representative, and shall include the expected start time, expected duration, character of work activity planned, names and telephone numbers of available contact persons (for additional information or questions), contact numbers for complaints, and any other relevant parameters or programs. Households within the eligibility zone shall receive notice regarding their eligibility for hotel vouchers at the same time or earlier.

4) **Mitigation Requirements/Activity Restraints:** When construction is conducted during Nighttime Hours and such activity emits noise levels that exceed ambient noise levels at residential properties, (contractor) shall utilize best reasonable management practices to mitigate construction noise impacts to the adjacent property owners. Best reasonable management practices include the following:
   a. Using reasonable best efforts to complete the construction as quickly as

4
Denver (Only) Noise Ordinance
Permit Variance Application Template

possible.
b. Minimizing nighttime construction duration near residential areas whenever possible.
c. Re-routing of truck traffic away from residential streets when possible.
d. Conducting truck loading, unloading and hauling operations so that noise levels are kept to a minimum
e. Configuring equipment on the site to minimize back-up alarm noise, where practical and feasible (for example, by using circular movement of trucks).
f. Shielding jackhammers, saws, and pavement breakers through use of an existing sound barrier wall or temporary barrier where practicable
g. Maintaining all equipment to meet manufacturer's specifications.
h. Informing employees, contractors and subcontractors performing construction of the general requirements of this variance and exercising best efforts to ensure that such employees, contractors and subcontractors follow best management practices in mitigating construction noise.

5) **Monitoring:** (Contractor) shall perform monitoring sufficient to demonstrate compliance with the requirements of the noise variance and to demonstrate to the community the noise levels that are present.
   a. Noise measurements shall be collected using ANSI guidelines for community noise monitoring
      i. Manufacturer's specifications for appropriate meter use shall be followed.
      ii. All noise measurements shall be made using the A-weighted scale (dB(A)) and a slow response. Fast response measurements may be used to measure impact noise levels.
      iii. Noise measurements shall be made at the nearest residential property line, unless physically impractical.
   b. All nighttime construction activity shall be initially monitored. Monitoring shall include spot measurements, as appropriate and hourly Leq. Monitoring shall be required for the following activity groups, but not be limited to:
      i. Joint Repair
      ii. Milling Operations
      iii. Rubble load-out
      iv. Paving operations
   c. Monitoring shall meet the following requirements:
      i. Each construction activity shall be monitored a minimum of two days for Lmax and hourly Leq levels to establish an activity baseline for each activity when initially undertaken, and to establish the expected worst case situation (outside lane).
      ii. Noise monitoring shall be provided in response to all noise complaints.

5
Denver (Only) Noise Ordinance
Permit Variance Application Template

iii. All noise monitoring data and documentation shall be provided to DEH at least weekly when applicable, and such data shall be available to the public from DEH. DEH and their designated representatives may inspect collected data more frequently.

d. The following documentation, in a manner and form mutually agreed upon by CDOT, (contractor) and DEH, shall be provided for noise monitoring that is conducted:

i. Manufacturer names, model numbers, and serial numbers of each SLM and acoustical calibrator used.
ii. Software manufacturer, program and version.
iii. Dates of annual certified calibration of SLM, microphone and acoustical calibrator.
iv. Pre- and post- monitoring calibration data for the Sound Level Meter.
v. Date and specific location (address if appropriate) of monitoring.
vi. Start time and end time of monitoring
vii. Ambient weather conditions including temperature, relative humidity, wind speed and cloud cover.
viii. Signature of technician collecting the data
ix. List of each hourly Leq for the monitoring period, with associated Lmax levels.
x. All measurements associated with any unusual noise events that occurred, cause of such event if known, correction of such event (if any), and adjusted and unadjusted measurements.

6) **Complaint Notification and Response:** (Contractor) shall ensure that methods are available to receive, address, and respond to concerns raised by people in the community, through:
   a. Assuring that a field representative is available to respond to complaints regarding construction noise levels and provide monitoring. The field representative shall be empowered to shut down construction activity, authorize correction or remediation of sources of excess noise, and authorize resumption of construction activity as necessary to maintain compliance with allowable noise levels.
   b. Providing telephone access to a field representative during hours of project activities to receive complaints or comments from the public for the duration of the project. All complaints immediately shall be recorded, investigated and addressed as appropriate by the field representative and reported to DEH in a manner mutually agreed by DEH, CDOT and (contractor). A response, in a reasonable form requested by the caller, summarizing the investigation and any

6
Denver (Only) Noise Ordinance
Permit Variance Application Template

corrective actions taken by CDOT and (contractor) shall be provided to the caller. Written copies of complaints received and responses by (contractor) shall be provided weekly to DEH and CDOT.

All application requirements and chapter 36 ordinance requirements regarding night time construction noise activities must be coordinated by the contractor with the City/County Denver. The contractor is fully responsible for the timely submittal of the variance application and fulfilling the requirements set forth by the City/County of Denver to allow construction activities during p.m. hours under the granted variance.

APPENDIX A
MMP – DRAFT TEMPLATE &
MMP CHECKLIST

MATERIALS MANAGEMENT PLAN – Draft Template
Project Name
Project Location / Address

Prepared for—
Name

Address

Prepared by—
Name
Address

Date

Add additional project information and photographs as needed to the title page

TABLE OF CONTENTS

1 Introduction 1
2 Purpose 1
3 Project Contacts 1
4 Environmental Responsibilities 2
5 Environmental Background 3
6 Materials Management 3
6.1 Dust 3
6.2 Soil 4
6.2.1 Soil Management 4
6.2.1 Field Screening Protocol 6
6.2.2 Soil Sampling Protocol 6
6.2.3 Stockpiling Soil 6
6.3 Construction Debris 7
6.4 Stormwater 7
6.5 Groundwater 7
6.6 Historic Landfill Debris 8
6.7 Asbestos in Soil 8
6.8 Infectious Waste 8
6.9 Other Special Wastes 9
6.10 Monitoring Wells 10
6.11 Disposal 10
7 Decontamination 11
8 Complaints 11
9 Site Security 12
10 Reporting 12

TABLES

Table 1: (as needed)
Table 2: (as needed)
Table 3: (etc.)

ATTACHMENTS

Attachment 1: (for example, Site Location)
Attachment 2: (for example, Soil Analytical Results)
Attachment 3: (for example, Groundwater Analytical Results)
Attachment 4: (for example, Groundwater Potentiometric Map)
Attachment 5: (for example, Area of Potentially Contaminated Soil)
Attachment 6: (for example, Area of Potentially Contaminated Groundwater)
Attachment 7: (for example, CCoD's Guidance for Soil Re-use on Third Party Sites)
Attachment 8: (for example, CCoD's Asbestos-Contaminated Soil Standard Operating Procedure)

1 INTRODUCTION

Within the introduction, include project location, current use, planned site use/redevelopment, who the work is being conducted for, very general scope of work to be performed/planned soil and or groundwater disturbing activities, and very generally why the MMP is needed.

2 PURPOSE

Example language follows, which should be modified to meet project-specific needs.

The purpose of this Materials Management Plan (MMP) is to provide a guidance document to manage contaminated materials, if encountered, during the site development. The MMP is designed to minimize worker exposure to potentially contaminated material, to minimize the potential of releases to the environment, and to facilitate proper disposal of materials developed during construction activities. The general contractor is responsible for following all appropriate regulations, obtaining the proper permits, and incorporating environmental information from this MMP into their safety plan. The general contractor is also responsible for providing this MMP to its staff and subcontractors and for compliance with the MMP. Through implementation of this MMP, the City and County of Denver (CCoD) will be immediately notified of potential environmental-related findings pertaining to construction activities at the site.

3 PROJECT CONTACTS

An example follows, which should be modified to meet project-specific needs.

Organization	Role/Responsibility	Contact Information
City and County of Denver, and list the specific department	CCoD Project Manager (additional information as needed)	Name Organization Office phone number Cell number email
City and County of Denver, Department of Environmental Health (DEH)	Environmental Quality Technical Oversight	Name Organization Office phone number Cell number If no immediate response, then 720-460-1706 email

Organization	Role/Responsibility	Contact Information
Name of the General Contractor	General Contractor, Construction Project Management; Immediate notification to DEH of potential environmental concerns	Name Organization Office phone number Cell number email
Name of major Subcontractors (as needed)	Example: Dewatering Contractors under General Contractor Immediate notification to DEH of potential environmental concerns	Name Organization Office phone number Cell number email
Name of Environmental Firm	Materials Management Plan Implementation; Immediate notification to DEH of potential environmental concerns	Name Organization Office phone number Cell number email

4 Environmental Responsibilities

The project team, either via the CCoD project manager or the general contractor, will hire an environmental firm to have a trained environmental professional onsite to implement the MMP. Examples of responsibilities are below and should be edited to meet project-specific needs.

Environmental Professional Responsibilities:

- Be a competent individual experienced with a) field identification of potentially contaminated material and potential environmental finds (e.g. abandoned underground storage tanks, asbestos awareness), b) characterization, c) management, and d) disposal.
- If needed for the project, the Certified Asbestos Building Inspector (CABI) will be trained and certified in accordance with Air Quality Control Commission Regulation No. 8, (5 CCR 1001-10, Part B).
- Be onsite when work is conducted within areas of known or suspected contamination as identified in the 'Background' section of the MMP. Be on-call when work is conducted outside of those areas.
- Perform field screening in adherence to the MMP.
- Complete daily field notes.
- Track and/or sign tickets and manifests for material hauled offsite for either reuse or disposal.
- Ensure adherence to the MMP.
- Provide daily updates to CCoD.
- Notify CCoD immediately of any unexpected environmental conditions, concurrently notify the WWMD Project Manager.

General Contractor Responsibilities:

- Provide all necessary equipment and personnel (i.e. health and safety officer, foreman, laborers, etc.) to implement the MMP.
- Coordinate with the environmental professional, DEH, and the CCoD project manager prior to beginning work to review the implementation of MMP requirements.

- Provide asbestos awareness training to site personnel who will conduct soil work.
- Adhere to the MMP.
- Ensure that their subcontractors adhere to the MMP.
- Ensure that disposed material goes to the Denver-Arapahoe Disposal Site (DADS) landfill.
- Ensure that waste material is not disposed onsite, in storm drains, sanitary sewers, streams, or other waterways.

Project Health and Safety Plan:
Workers and managers associated with intrusive site activities will be required to undergo a one-time health and safety orientation meeting at the start of the project, such as a brief onsite description of site conditions or in coordination with asbestos awareness training. A site-specific safety management plan will be prepared as required by the construction contract, and it will incorporate information as required by 29 Code of Federal Regulations (CFR) 1910 and 29 CFR 1926. The general contractor may share its plan with its subcontractors or require each subcontractor to prepare its own plan.

5 Environmental Background

Describe the environmental issues/concerns associated with the site and their current status. For example, this section may describe historic gasoline stations and current cleanup actions, fill material, historical landfill use, past disposal of coal-based fill material, building debris with potential asbestos material, potential for asbestos in soil, and known or potential soil and groundwater contamination. Provide figures and maps as needed to show the areas where these environmental concerns may be encountered during redevelopment work. The more the MMP can define the area and depth of known contaminated material, then the more stream-lined the field process may be.

6 Materials Management

Examples of information are provided below for dust, soil, construction debris, stormwater, groundwater, landfill debris, asbestos, other miscellaneous wastes, and disposal. However, the materials of concern subsequent subsections will be project-specific. The project-specific materials of concern should be summarized and then discussed in detail below.

The following statement must be included in the MMP:
If unknown/unidentified underground storage tanks, drums, odorous soil, stained soil, asbestos-cement pipe, transite, building debris or waste materials are encountered during the project, the general contractor shall immediately stop work in the area of the discovery until DEH makes a determination of how to proceed. The general contractor shall immediately notify DEH of the discovery via the phone number 720-460-1706. Following discussions with DEH and the CCoD project manager, additional characterization, remediation, and/or analyses may be required. Work may continue in other areas of the project site while the discovery is resolved.

6.1 Dust

The following statement must be included in the MMP:
The general contractor shall take reasonable measures to prevent particulate matter from becoming airborne and to prevent the visible discharge of fugitive particulate emissions beyond the property

boundary on which the emissions originate. The measures taken must be effective in the control of fugitive emissions at all times on the site, including periods of inactivity such as evenings, weekends, and holidays as well as any other period of inactivity.

Additionally, the general contractor will determine if the minimum requirements for an Air Pollution Emissions Notice (APEN) in accordance with 5 CCR 1001 – Air Quality Control Commission are met and obtain the permit if required. Such requirements may include whether the project site is less than 25 contiguous acres and whether site work will be less than 6 months in duration.

6.2 SOIL

Soil may be excavated from a project site possibly due to contamination or excess soil, and this initial paragraph(s) for this section should summarize when soil will be generated at the project site (e.g. excavation, caisson drilling, etc.).

6.2.1 Soil Management

This subsection should review the project-specific types of contaminated soil that may be encountered, when samples should be collected, the analyses needed, criteria for determining when soil must be disposed, manifesting, field screening protocol, stockpiling soil, and disposal. It is assumed that the project has conducted Phase II type environmental investigations.

CCoD's general approach for managing soil is as follows and should be incorporated into the site specific MMP as appropriate.

Clean soil

- Reuse onsite –
    - No testing is required, but an environmental professional will be onsite to verify that there are no field indications of contamination or construction debris.
- Export offsite -
    - To another City property – An initial sample will be collected for laboratory analysis of site-specific constituents of concern. Additional samples will be collected for analyses when there is a change in soil characteristics. An environmental professional will be onsite when the soil is either stockpiled or direct loaded into trucks to verify that there are no field indications of contamination or construction debris.
    - To a third party's property – Soil samples will be collected every 500 cubic yards for analysis of an extensive list of potential contaminants per the City's guidance document (see attachment____). An environmental professional will be onsite when the soil is either stockpiled or direct loaded into trucks to verify that there are no field indications of contamination or construction debris.
    - Material is considered suitable for offsite reuse if a) laboratory analytical results meet the Colorado Department of Public Health and Environment (CDPHE) residential standards and the CDPHE guidance for arsenic, and b) field observations indicate no construction debris and no contamination (e.g. no odor, no staining, and field measurements representative of background conditions).
- Disposal -
    - A representative soil sample will be analyzed for the site-specific constituents of concern, and CCoD will obtain the approval for disposal at the DADS landfill. The landfill will accept

soil as 'clean' when it is free of contaminants, debris, organic material, and objects greater than 6-inches in any dimension. A waste ticket, provided by CCoD, will accompany each truck load to the DADS landfill. For large projects, drop tickets may be arranged with the DADS landfill.

Imported soil

If fill material will be brought onto the site, then the following language must be included in the MMP:

- Any fill material or soil to be moved to and placed on CCoD-owned property or placed on real property to be transferred to CCoD must be free of known contamination (observed or previously documented) and be acceptable for unrestricted residential use. Contact Dave Erickson, DEH (720-865-5433) for clarification, if needed, regarding this CCoD requirement.

Contaminated soil

- Known contamination -
  - Areas of known contamination will be documented during pre-construction environmental investigations and maps/figures of these areas will be included in the MMP.
  - The contaminated soil will be analyzed for the site-specific constituents of concern during the investigation work.
  - Disposal profiles will be prepared by CCoD and disposal manifests will be obtained by CCoD.
  - Each type of contaminated soil (e.g. petroleum, asbestos, landfill, etc.) requires its specific manifest; they are not interchangeable.
  - When known contamination is encountered during construction work, it may either be temporarily stockpiled or directly loaded and hauled to the DADS landfill with the appropriate manifest.
  - Additional sampling and laboratory analytical results are not required for this known contamination unless field observations indicate a change in the type of contaminants. The need for and type of analyses will first be discussed with CCoD.

- Unanticipated soil contamination -
  - If field indications of soil contamination are encountered outside of the area of known contamination, and CCoD concurs that the field characteristics indicate that it is the same type of soil as the known contamination, then the soil will be disposed using the previously obtained manifests. No additional testing will be required.
  - Whenever different types of contamination are encountered based on field observations, work will temporarily stop in that immediate area so that the soil may be sampled and analyzed. The types of constituents to be analyzed will be discussed with CCoD and typically rushed results will be requested from the laboratory. As a result, work in the immediate area may be stopped for a minimum of 1 week.
  - If potential asbestos-containing material or Regulated Asbestos Containing Soil (RACS) is encountered by the asbestos-awareness trained personnel, a Certified Asbestos Building Inspector (CABI) will be called to the site to conduct sampling as discussed later within this MMP and within the attached document 'Asbestos-Contaminated Soil Standard Operating Procedure'.
  - As determined by the CCoD project manager, either CCoD or the general contractor will prepare the disposal profile and obtain the manifests for disposal at the DADS landfill.

6.2.1 Field Screening Protocol

Field screening will consist of monitoring the soil for odors, headspace, ambient air measurements, and staining that does not include natural variations such as mottling or iron staining. For headspace readings, a soil sample will be placed in a sealed lock-tight plastic bag or equivalent container until volatile constituents equilibrate inside the bag. The headspace will be measured using a photoionization detector (PID). A headspace reading of 10 parts per million (ppm) or less is considered to represent background conditions. If work is conducted within a historical landfill, then methane readings of the ambient work-space will also be monitored with a flammable gas monitor. Monitoring will be performed in and downwind of work areas.

If PID readings exceed 50 ppm or methane readings at or exceeded 5% of the Lower Explosive Level (LEL), then work in that immediate area will stop and the work area will be allowed to air out for 15 minutes after which additional ambient air readings will be obtained. If readings still exceed the acceptable levels, additional readings will be taken after a total of 30 minutes. If readings still exceed, then the CCoD project manager and DEH will be notified and engineering controls will be discussed. Work in the area will resume only after acceptable levels are obtained.

6.2.2 Soil Sampling Protocol

Samples for laboratory analytical analyses may be collected using equipment such as a backhoe, hand-auger, or sampling spoon. To eliminate loss of potential volatile organic constituents (VOCs), samples will be collected from fresh excavation side walls, excavation floor, or from several inches beneath the surface of stockpiled soil. If composite soil samples are collected, representative subsamples will be placed in a mixing bowl and thoroughly mixed except those samples for VOC analysis. Instead, a portion of the composite sample will be placed directly into the sample container. Soil samples will be placed into clean laboratory-supplied containers, capped, labeled, and placed in ice-chilled containers for transport to a certified laboratory under strict chain-of-custody protocol.

6.2.3 Stockpiling Soil

Soil that is known or suspected to be contaminated may be stockpiled onsite; however, it must be placed on 10-mil or greater plastic sheeting. Clean soil that is stockpiled is not required to be placed on plastic sheeting. Stockpiled soil must be managed, such as by covering with plastic sheeting, to prevent dust. Additionally, stormwater best management practices (BMPs) will be implemented to prevent runoff.

Stockpiled soil that is saturated (e.g. excavated from below the water table) will be placed on 10-mil plastic sheeting that is sloped to collect the water in a plastic-lined sump. Accumulated water will be sampled, if not previously sampled, and disposal options will be reviewed with DEH and the CCoD project manager.

Stockpiled soil will be limited in size to 500 cubic yards and should be within fenced areas (i.e. within the project site fenced area) to limit unauthorized access. The number of onsite stockpiles and the length of time they are onsite should be held to a minimum.

6.3 Construction Debris

Prior to demolition activities, construction material, whether as a still-standing building or observed as remnants buried in the subsurface, or should be evaluated by an environmental professional for the presence of asbestos and lead based paint.

If, prior to excavation, existing buildings will be demolished and debris removed from the site, the general contractor will:

- Obtain a building demolition permit from CDPHE Air Quality Control Division;
- Remove Asbestos Containing Building Material, except for Category I non friable ACM from buildings; and
- Inspect the footprint and surround areas of the former building for ACM.

If the material is free of lead-based paint and asbestos, it may be recycled if deemed appropriate by the CCoD project manager. If it is disposed, it must go the DADS landfill. A waste ticket, provided by CCoD, will accompany each truck load to the DADS landfill. For large projects, drop tickets may be arranged with the DADS landfill.

6.4 Stormwater

The general contractor will obtain a General Permit for Stormwater Discharges Associated with Construction Activity from the CDPHE Water Quality Control Division. This is also referred to as the Colorado Discharge Permit (CDPS) number COR-030000. Per CDPHE, "Stormwater Construction Permit coverage is required by State and Federal regulations for stormwater discharged from any construction activity that disturbs at least 1 acre of land (or is part of a larger common plan of development or sale that will disturb at least 1 acre)." The general contractor is responsible for complying with the permit.

6.5 Groundwater

When redevelopment activities will encounter groundwater, the CCoD project manager with assistance from DEH will determine whether offsite disposal, potential reuse onsite, or obtaining a permit and treating the water onsite is most feasible for the project. Project specific groundwater laboratory analytical results are required to make this determination and also to assess which permit may be obtained.

Most CCoD projects will either require a Colorado Discharge Permit (CDPS) COG-070000 General Permit for Construction Dewatering Discharges or a CDPS COG-315000 General Permit for Discharges from Remediation Activities. Both permits are issued by the CDPHE Water Quality Control Division. Very generally, the COG-07000 permits are issued only if it can be proven that the project site and surrounding area have no environmental concerns. Whereas the COG-315000 permits are issued when there are onsite and/or area environmental concerns and when groundwater quality does not meet the numeric standards of the receiving surface water, even if the groundwater concentrations represent background conditions.

The general contractor is responsible for ensuringthat water is managed in accordance with applicable federal, state, and local regulations and for meeting all requirements of a permit. The general contractor cannot discharge groundwater to a public stormwater system without obtaining the proper permits.

6.6 Historic Landfill Debris

Historical municipal landfills may be encountered during CCoD redevelopment activities. Most of these landfills contain construction and demolition debris and/or household trash and they do not contain hazardous waste or asbestos material. At these locations, the old landfill debris may be excavated and disposed at the DADS landfill after first obtaining the landfill approval and manifests. Sampling and laboratory analysis are typically not required under this scenario.

During excavation, a Certified Asbestos Building Inspector (CABI) that also has experience in identifying potential environmental materials of concern will be onsite to observe and ensure that materials of potential concern are set aside for testing prior to disposal. The CABI will also monitor the excavation for VOCs and methane as discussed above in Section 6.2.2.

Examples of environmental materials of concern include drums, batteries, and stained or odorous soil. These materials may be screened, sampled, and stockpiles as described in Sections 6.2, 6.3, and 6.4 until they are characterized for disposal.

Asbestos is another environmental material of concern that may be found in historical landfills and may be present as individual pieces of asbestos wrapped pipe, transite, or debris.

However, asbestos may also be found in certain types of ash layers within historical landfills. If it is found in these ash layers, then the project must implement the CCoD SOP for asbestos containing soil and prepare a separate Best Management Practices (BMP) document for DEH and CDPHE approval prior to beginning site work and included as part of the MMP. The BMP may be written so that the asbestos ash layers area segregated and managed as asbestos containing soil, and the remaining soil/material would not require special management unless the onsite CABI found other suspect material. Any site specific information such as area, depth, and characteristics would assist the onsite CABI and streamline the field process.

6.7 Asbestos in Soil

The following language must be included in the MMP:
In the event that Regulated Asbestos Containing Soil, as described in the Colorado Department of Public Health and Environment (CDPHE) 6 CCR 1007-2 Part 1 – Regulations Pertaining To Solid Waste Sites and Facilities, Section 1.2 Definitions and Section 5.5 (Management of Regulated Asbestos Contaminated Soil [RACS]), effective January 14, 2015, is encountered during soil disturbing activities, the DEH Asbestos-Contaminated Soil Management Standard Operating Procedure (SOP, effective December 3, 2010) will be followed (see Attachment___). Any changes to the implementation of SOP would be done under a notification to CDPHE (24 hour or 10 days) for their approval following review of the changes by DEH. The notification to CDPHE addressing compliance with the new rules or specific project circumstances can be submitted via the project's environmental consultant or DEH.

6.8 Infectious Waste

The proper management of infectious wastes begins with identification. Given that the potential infectious wastes are associated with historical landfills, it is likely that the waste materials will not have many of the common identification, labeling, and containerization characteristics observed with medical wastes today. The following information has been provided to aid the general contractor and

environmental professional in identifying potentially infectious wastes. The CCoD project manager and DEH will be notified if infectious waste is encountered.

The EPA, the Center for Disease Control (CDC), and OSHA all have recommended classifications to deal with potentially infectious waste matter, with the primary emphasis being medical wastes. Based on EPA's classification, materials that should be treated as infectious wastes include:

- Isolation waste;
- Cultures, stocks and associated biologicals;
- Human blood and blood products;
- Pathological wastes like body parts, tissues, organs, and fluids removed during surgery, pathology or biopsy;
- Sharps (edged or pointed metal, glass, or plastic medical equipment) such as hypodermic needles, syringes, intravenous needles, scalpel blades, lances, disposable pipettes, capillary tubes, laboratory equipment, glass slides, test tubes, and broken glass;
- Animal carcasses, body parts, and bedding;
- Personal protective equipment, swabs, pipettes, spreaders, gloves, specimen and culture containers, cups, petri dishes, and flasks;
- Laboratory waste such as intravenous tubing, drainage tubing, pouches, dressings, disposable filters, towels, aprons, gowns, bedding, pads; and
- Dialysis unit wastes.

If field monitoring during construction work in fill areas uncovers any of the aforementioned materials, they will be managed as infectious wastes. Following identification of waste materials, the work in the immediate area will be suspended in order to properly profile the waste for disposal per CCR 25-15-403.

- Restrict access to the infectious waste with fencing or other material;
- Wet the waste to reduce potential for airborne migration of materials;
- The infectious waste will be excavated, logged and containerized. Once placed in appropriate containers, the infectious waste will be labeled and placed in a secured storage area until removal by a registered infectious waste management company; and
- Individuals involved in excavating, identifying and segregating infectious waste will wear personal protective equipment appropriate to the type of infectious waste encountered. At a minimum, all workers involved in the identifying and segregation of infectious waste will wear disposable overalls and booties, disposable gloves, work books, and clear plastic full face mask.

6.9 Other Special Wastes

Special wastes could include items such as drums, chemical or fuel containers, batteries, tar, sludge, slag/coal/ash,, materials that are hazardous waste, and potential polychlorinated biphenyls (PCBs) containing equipment (transformers, light ballasts, voltage regulators, capacitors and circuit breakers). These materials may be present in small quantities and can be difficult to characterize. Upon identification of special wastes, excavation at that immediate location will cease until additional assessment by the environmental professional can be completed as coordinated with CCoD. The environmental professional will attempt to assess special wastes, including prudent and safe observation for the following:

- Markings and or labels on containers/drums, condition of the containers/drums (i.e. rust, holes, damage, corrosion) and other indications of contents;
- Indications of unsafe conditions, including swelling drums, leaking, fumes, odors, etc;
- Conditions of materials associated with the special wastes; and
- Assessment for evidence of release, obtained by utilizing field instruments (i.e. PID, LEL) and professional judgment.

Only under the direction of the environmental professional and after discussions with DEH and the CCoD project manager will handling of any special wastes be completed. When handling is required, the following precautions will be taken:

- Handling will be minimized whenever possible;
- When necessary, handling will be employed by mechanical means including the use of site excavation equipment;
- Pressurized/swelling drums, suspected explosives, potential shock-sensitive materials or other potentially dangerous items will not be handled until a person with appropriate experience with these situations has been consulted;
- All special wastes will be placed on 10-mil plastic sheeting and covered until additional assessment has been completed by the environmental professional (the time frame will allow for laboratory testing and obtaining a profile and manifest for disposal);
- All stockpiles of special waste will be covered immediately or containerized, and will remain covered or containerized until final removal;
- Suspicious materials will be further evaluated by the environmental professional. When additional assessment of this material indicates that the material does not meet applicable regulatory requirements for disposal as a non-hazardous waste, the environmental professional and DEH will arrange for off-site disposal at a licensed facility; and
- Where suspicious material is determined to be non-hazardous by the environmental professional and DEH through additional assessment, the material may be disposed as non-hazardous solid waste.

Waste may be hazardous if it contains a listed hazardous waste or enough hazardous constituents to exhibit a hazardous waste characteristic. Listed wastes are discussed in 6 CCR 1007-3 Part 261 Subpart D. Testing and disposal will be coordinated with DEH.

6.10 Monitoring Wells

If groundwater monitoring wells could be encountered during excavation and construction activities, then the following procedures will be followed.

Work will be conducted around monitor wells so as not to disturb their construction. If this is not possible, the well will be properly abandoned and then replaced after construction, as coordinated and conducted by the environmental professional; DEH will be notified and will coordinate abandonment of monitoring wells.

6.11 Disposal

The following language must be included in the MMP:

The general contractor shall direct non-recyclable, non-hazardous wastes from the CCoD-owned or controlled property or facilities to the DADS landfill for disposal.

As determined by the CCoD project manager for the site, either the general contractor or CCoD may a) set up the disposal account with the DADS landfill, b) complete the waste profile forms, and c) obtain manifests from WM for the DADS landfill. As practical, the material will be profiled, and manifests will be obtained before site work begins.

If the soil is determined to be hazardous based on the analytical data, then special waste management and disposal options will be discussed with the CCoD project manager and DEH. Hazardous waste cannot be disposed at the DADS landfill.

7 DECONTAMINATION

Equipment that has come into contact with environmentally-affected material, such as soil, will be decontaminated prior to leaving the site to minimize the potential of contaminating offsite properties. Decontamination procedures will include using hand tools such as shovels, brooms, and brushes to remove the material from the equipment. If the environmental professional finds it necessary, the equipment will be further decontaminated with a pressure washer. The spent decontamination water will be collected in plastic-lined basins and pumped into water-tight containers. The general contractor will be responsible for analyzing the wastewater and coordinating with CCoD to dispose of the decontamination water.

8 COMPLAINTS

Any complaints received by the general contractor will be immediately reported to the CCoD project manager. Additionally, any environmentally related complaint, such as noise, odor, or dust, will be immediately reported to DEH. Complaints should be addressed with 24 hours.

The following statement must be included in the MMP:
The project must adhere to CCoD's noise ordinance. Exempted hours for construction in the City and County of Denver are from 7 A.M. TO 9 P.M. Monday through Friday and 8 A.M. TO 5 P.M. on Saturdays and Sundays per Sections 36-6.(B)(7) AND 36-7.(5)A., B. and C. of Chapter 36 Noise Control, Denver Revised Municipal Code (DRMC). If there is an anticipated need to work outside of the exempted hours for construction: 1) the general contractor will need to make a request for a nighttime noise variance as allowed for in Section 36-7.(5)C. of the DRMC, and 2) the variance process needs to be started a minimum of two to three months prior to the desired start date of any work needing to occur outside of exempted hours. Any noise variance questions should be directed to Paul Riedesel, DEH Denver Community Noise Program (phone 720-865-5410; FAX 720-865-5532) a minimum of three months prior to the start of the project.

9 SITE SECURITY

The general contractor will be responsible for maintaining effective project access control to prevent the public from gaining access to the potentially contaminated materials exposed during the development activities.

10 REPORTING

The environmental professional will complete a summary report outlining the implementation of this MMP, which will include the following:

- Description of the work completed;
- Summary of the environmental professional onsite observations;
- Electronic deliverable of field observation log book(s);
- Summary of materials that were managed and the procedures used;
- Quantities and disposition of materials managed;
- Description of field and laboratory sampling and results;
- Waste manifests;
- Maps showing the locations of pertinent features;
- Labeled site photographs; and
- Any other pertinent project information.

Materials Management Plan (MMP) Checklist for WWMD

This is not as comprehensive as a MMP nor does it replace a MMP
It is to be used in conjunction with the Material Management Plan Template
And Coordinated with DEH as Needed
Draft 1-27-16

1. Where is the project located?

2. What is the project scope?

3. Who are the key project contacts (i.e. City PM, environmental contact (DEH and/or firm), GC, key subcontractors)?
   a. What are their responsibilities?
   b. What is the call-down list?
   c. Who is responsible for maintaining environmental compliance on the site?
   d. Who is responsible for reporting environmental conditions to the City and the regulatory agencies?
   e. Who has environmental liability for the project?

4. What are the known or suspected environmental concerns and contaminants associated with the work area?

5. Will the project utilize onsite environmental professionals, Certified Asbestos Building Inspectors (CABIs), and/or workers with asbestos awareness training?

6. Are there environmental-related structures that need to be accommodated, such as monitoring wells, remediation systems, or underground tanks?

7. Is a stormwater permit needed?
   a. Who is responsible for permitting and compliance?
   b. What Best Management Practices (BMPs) and/or protocols will be implemented at the site?

8. Will groundwater be encountered?
   a. Are there known contaminants?
   b. How will the water be managed?
   c. Has the water been tested (groundwater may naturally have higher concentrations than what is typically allowed in a discharge permit)?
   d. Will the water be disposed offsite (pump and haul)?
   e. Will a discharge permit be required?
   f. Will treatment before discharge be required?
   g. Who will conduct testing, hauling, permitting, treatment, and/or compliance actions?
   h. What BMPs and/or protocols will be implemented at the site?

9. Will soil be encountered?
   a. Is there an environmental assessment for the work area?
   b. Does an environmental report indicate the potential for contaminated soil, asbestos, historic landfill debris, landfill gas, or other environmental conditions?

c. Has the soil, and/or other subsurface material, been analyzed for potential contaminants?
d. Per the analytical results, are there worker health and safety issues that need to be addressed? Who will be onsite to recognize potential environmental conditions and concerns?
e. What BMPs and/or protocols will be implemented at the site? Asbestos in soil must be managed in accordance with the City's asbestos SOP.

10. Will excess soil be generated?
    a. Where will the excess soil be placed?
    b. How will stockpiled soil be managed to prevent dust and runoff?
    c. How will the water from the stockpiled saturated soil be collected, tested, and managed/disposed?
    d. Testing is required to demonstrate 'clean' soil and to document contaminated soil (and/or material) prior to disposal. Who will conduct the testing and for which analyses?
    e. What BMPs and/or protocols will be implemented at the site?

11. What are the field screening protocols?

12. What are the sampling protocols?

13. How will wastes be managed?
    a. What wastes will the project generate?
    b. Liquid waste and hazardous waste cannot go to the DADS landfill. How will this waste be managed?
    c. Will the contractor or the City set up the disposal account with Waste Management for disposal at the DADS landfill?
    d. Are tickets for uncontaminated/unregulated waste and/or manifests for contaminated/regulated material needed?
    e. For contaminated/regulated wastes, has a profile been created and manifests obtained?
    f. Who will be present onsite to maintain control of tickets and manifests?
    g. If there are multiple types of contaminated material, training and maps will help onsite personnel recognize which manifest is needed for certain waste types.
    h. What BMPs and/or protocols will be implemented at the site?

14. Will soil be imported to the site? Does it meet State residential cleanup standards and City guidance for accepting soil?

15. What is the protocol for decontaminating environmentally-affected equipment?

16. Who is responsible for maintaining site security to prevent the general public from gaining access to potentially contaminated material?

17. Who will receive and respond to complaints? How will the City be notified?

18. What information will be included in the summary report that outlines the implementation of the MMP? Who will prepare this report?

19. Required Language

Disposal - The following language must be included in the MMP:
The general contractor shall direct non-recyclable, non-hazardous wastes from the CCoD-owned or controlled property or facilities to the DADS landfill for disposal.

Unknowns - The following statement must be included in the MMP:
If unknown/unidentified underground storage tanks, drums, odorous soil, stained soil, asbestos-cement pipe, transite, building debris or waste materials are encountered during the project, the general contractor shall immediately stop work in the area of the discovery until DEH makes a determination of how to proceed. The general contractor shall immediately notify DEH of the discovery via the phone number 720-460-1706. Following discussions with DEH and the CCoD project manager, additional characterization, remediation, and/or analyses may be required. Work may continue in other areas of the project site while the discovery is resolved.

Dust - The following statement must be included in the MMP:
The general contractor shall take reasonable measures to prevent particulate matter from becoming airborne and to prevent the visible discharge of fugitive particulate emissions beyond the property boundary on which the emissions originate. The measures taken must be effective in the control of fugitive emissions at all times on the site, including periods of inactivity such as evenings, weekends, and holidays as well as any other period of inactivity.

Additionally, the general contractor will determine if the minimum requirements for an Air Pollution Emissions Notice (APEN) in accordance with 5 CCR 1001 – Air Quality Control Commission are met and obtain the permit if required. Such requirements may include whether the project site is less than 25 contiguous acres and whether site work will be less than 6 months in duration.

Asbestos - The following language must be included in the MMP:
In the event that Regulated Asbestos Containing Soil, as described in the Colorado Department of Public Health and Environment (CDPHE) 6 CCR 1007-2 Part 1 – Regulations Pertaining To Solid Waste Sites and Facilities, Section 1.2 Definitions and Section 5.5 (Management of Regulated Asbestos Contaminated Soil [RACS]), effective January 14, 2015, is encountered during soil disturbing activities, the DEH Asbestos-Contaminated Soil Management Standard Operating Procedure (SOP, effective December 3, 2010) will be followed (see Attachment___). Any changes to the implementation of SOP would be done under a notification to CDPHE (24 hour or 10 days) for their approval following review of the changes by DEH. The notification to CDPHE addressing compliance with the new rules or specific project circumstances can be submitted via the project's environmental consultant or DEH.

Noise - The following statement must be included in the MMP:
The project must adhere to CCoD's noise ordinance. Exempted hours for construction in the City and County of Denver are from 7 A.M. TO 9 P.M. Monday through Friday and 8 A.M. TO 5 P.M. on Saturdays and Sundays per Sections 36-6.(B)(7) AND 36-7.(5)A., B. and C. of Chapter 36 Noise Control, Denver Revised Municipal Code (DRMC). If there is an anticipated need to work outside of the exempted hours for construction: 1) the general contractor will need to make a request for a nighttime noise variance as allowed for in Section 36-7.(5)C. of the DRMC, and 2) the variance process needs to be started a minimum of two to three months prior to the desired start date of any work needing to occur outside of exempted hours. Any noise variance questions should be directed to Paul Riedesel, DEH Denver Community Noise Program (phone 720-865-5410; FAX 720-865-5532) a minimum of three months prior to the start of the project.

APPENDIX B
REGULATED ASBESTOS CONTAMINDATED SOIL
STANDARD OPERATING PROCEDURE

ENVIRONMENTAL QUALITY
DENVER PUBLIC HEALTH & ENVIRONMENT

Regulated Asbestos Contaminated Soil Standard Operating Procedure

For City and County of Denver

Prepared by the Denver Department of Public Health and Environment

Environmental Quality Division

May 2, 2019

Table of Contents

1. Introduction 1
1.1 Purpose 1
1.2 Applicability 2
1.3 Non-RACS vs. RACS 3
1.4 Project-specific Regulated Asbestos Contaminated Soil Management Plan 3
1.5 Key Parties and Responsibilities 3
2. Process Flow and Decision Scenarios 6
2.1 Scenarios 6
2.1.1 Excavation in Areas with No Debris 6
2.1.2 Excavation in Areas with Non-Suspect Debris 6
2.1.3 Discovery of Suspect Debris or Suspect RACS During Excavation 6
2.1.4 Excavation in Areas with Known RACS 7
2.1.5 Subsurface Investigations 7
3. General Requirements 13
3.1 Training for Site Personnel 13
3.2 Health and Safety 14
3.3 CABI and AMS Requirements 14
3.4 Contractor Requirements 16
3.5 Notifications 17
3.6 Soil Reuse 18
4. Debris Identification 19
4.1 Debris Classified as Non-Suspect for ACM 19
4.2 Debris Classified as Suspect for ACM 20
5. Initial Actions and Stabilization for RACS Discovery 21
5.1 Temporary Stabilization Procedures 22
5.1.1 Horizontal Excavation Faces (Excavation Floors) 22
5.1.2 Vertical Excavation Faces (Excavation Side Walls or Trenches) 22

5.1.3 Standard Requirements for Temporary Sub-Surface Stabilization of RACS. 22
5.1.4 Standard Requirements for Permanent Stabilization of RACS 23
5.1.5 Standard Requirements to Stabilize Investigation-Derived Waste 23
5.2 Site Access Control 25
6. Suspect Asbestos Bulk Sampling 26
7. RACS Management 27
7.1 Hand Removal 27
7.2 Mechanical Removal 28
7.2.1 Establishing a RWA after Confirmed Discovery of RACS 29
7.2.2 Engineering Controls 29
7.2.3 RACS Disposal Procedures 30
7.2.4 Wind Speed Monitoring 33
7.2.5 Air Monitoring 34
7.2.6 RACS Stockpiling 37
7.2.7 Decontamination Procedures 39
7.2.8 Work Area Clearance 40
8. Close-Out Report 41
9. References 42

Figures

Figure 1 Excavation in Areas with No Debris 8
Figure 2 Excavation in Areas with Non-Suspect Debris 9
Figure 3 Discovery of Suspect Debris or Suspect RACS During Excavation 10
Figure 4 Excavation in Areas with Known RACS 11
Figure 5 Subsurface Investigations 12

Tables

Table 1 Key Parties and Responsibilities 4
Table 2 Responsibilities 5
Table 3 Removal/Disturbance (by hand or hand-held tools) of Non-Friable RACS 34
Table 4 Removal/Disturbance (by hand or hand-held tools) of Friable RACS 34
Table 5 Removal/Disturbance by Mechanical Means (Heavy Equipment) of Non-Friable RACS 35
Table 6 Removal/Disturbance by Mechanical Means (Heavy Equipment) of Friable RACS 35

Appendices

Appendix A CDPHE Approval Letter
Appendix B CABI Work Day Documentation Form
Appendix C Notification of Planned Soil Disturbing Activity
Appendix D Sample Collection Protocols and Analytical Methodologies

Acronyms

Acronym	Definition
ACM	Asbestos-containing Material
AHERA	Asbestos Hazard Emergency Response Act
AMS	Air Monitoring Specialist
AOC	Area of Contamination
AQCD	Air Quality Control Division
BDL	Below Detection Limits
BMP	Best Management Practice
CABI	Certified Asbestos Building Inspector
CCOD	City and County of Denver
CCR	Code of Colorado Regulation
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulation
CMU	Concrete Masonry Unit
CSWR	Colorado Solid Waste Regulations
DDPHE	Denver Department of Public Health and Environment
GPS	Global Position System
HEPA	High-efficiency Particulate Air
HVAC	Heating, Venting and Air Conditioning
IDW	Investigation-derived Waste
MMP	Materials Management Plan
mph	Miles Per Hour

Acronym	Definition
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NVLAP	National Voluntary Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
PCM	Phase Contrast Microscopy
PLM	Polarized Light Microscopy
Poly	Polyethylene
PPE	Personal Protection Equipment
PSRMP	Project-Specific Regulated Asbestos Contaminated Soil Management Plan
RACS	Regulated Asbestos Contaminated Soil
RWA	Regulated Work Area
TEM	Transmission Electron Microscopy

Definitions

"**Adequately wet**" means sufficiently wet to minimize visible emissions of dust and/or debris within the regulated work area (RWA) and to prevent the release of visible emissions from leaving the RWA. The observance of visible emissions, outside of the RWA, of dust and/or debris may be an indication that soils are not adequately wet.

"**Adjacent Receptor Zone**" means an area of uncontrolled access at a distance of 150 feet or less from the nearest RWA boundary during active Regulated Asbestos Contaminated Soil (RACS) disturbance. For the purpose of this definition, highways, streets, and roads without sidewalks, where only vehicles are permitted, are considered to be areas of controlled access and therefore not adjacent receptor zones. For the purpose of this definition "vehicle" means a device that is capable of moving itself, or of being moved, from place to place upon wheels, including bicycles and electrical assisted bicycles. For the purpose of this definition, an area for which access is not ordinarily controlled that is closed to the public during soil disturbing activities in the adjacent RWA is considered to be an area of controlled access and therefore not an adjacent receptor zone.

"**Amended water**" means water containing a wetting agent, such as a 50:50 mixture of polyoxyethylene ester and polyoxyethylene ether, or the equivalent, in a 0.16 percent solution (1 ounce to 5 gallons) of water, or as per manufacturer recommendations for the wetting of asbestos.

"**Air Monitoring Specialist**" (AMS) means a person trained and certified, in accordance with the requirements of Air Quality Control Commission Regulation No. 8 (5 Code of Colorado Regulation [CCR] 1001-10, Part B) (CDPHE, 2008), for the collection of air samples to determine airborne particulate and/or asbestos concentrations.

"**Asbestos**" means the asbestiform varieties of serpentine (chrysotile) and amphibole minerals, riebeckite (crocidolite), amosite (cummingtonite-grunerite), anthophyllite, actinolite, and tremolite.

"**Asbestos-containing material**" (ACM) means any material that contains more than one percent (1%) asbestos by weight, area or volume. It is during a CABI's RACS/Non-RACS Determination that ACM will be analyzed for.

"**Asbestos Worker**" means an individual trained and certified under the Colorado State Regulation No. 8, Part B to disturb, enclose, remove, and abate friable and non-friable asbestos containing material.

"**Certified Asbestos Building Inspector**" (CABI) means a person trained and certified in accordance with Air Quality Control Commission Regulation No. 8, (5 CCR 1001-10, Part B), for the identification of asbestos containing materials and the collection of samples to determine asbestos content inspection and sampling, and who has forty (40) verifiable hours of on the job asbestos in soils experience on a minimum of three (3) different asbestos in soils projects, conducted under either AQCC Regulation No. 8 or CSWR §5.5. The CABI shall be independent of the general contractor (GC) and/or abatement

contractor unless the CABI and the GC or abatement contractor are both direct employees of the property owner. However, the GC or abatement contractor may hire a subcontractor CABI, but the CABI shall not be a direct employee of the GC or abatement contractor.

"**Consultant**" refers to the entity contracted to perform all oversight actions in the form of training, inspections, field directions, air monitoring and documentation related to soil disturbing activities in accordance with this standard operating procedure.

"**CSWR**" refers to the Colorado Solid Waste Regulations (6 CCR 1007-2). The sections most applicable to this standard operating procedure are Section 5 "Asbestos Waste Management", and specifically Section 5.5 "Management of Regulated Asbestos Contaminated Soil (RACS)".

"**Debris**" means any discarded material that contains or consists of any of the following: construction, renovation and demolition debris (regardless of how it was generated), building or facility components, components of building systems (heating, venting, air condition [HVAC], plumbing, electrical, control, fire protection, roofing), components of pavement or drainage systems, industrial or machinery components, and/or mechanical components from motorized vehicles.

"Debris Determination" for the purpose of this standard operating procedure, means a determination, conducted in the field by the contractor and/or their sub-contractors for the possibility of visible debris to be either Non-Suspect for ACM or Suspect for ACM. Determinations of Non-Suspect/Suspect shall be based on the requirements set forth in Section 4.1 & 4.2 of this standard operating procedure.

"**Facility Component**" - for purposes of this standard operating procedure, means any part of a facility including equipment. For the purpose of this definition, "facility" means (as defined in Air Quality Control Commission Regulation No. 8 (5 CCR 1001-10, Part B): "any institutional, commercial, public, industrial, or residential structure, installation, or building (including any structure, installation, or building containing condominiums or individual dwelling units operated as a residential cooperative, but excluding: residential buildings having four or fewer dwelling units); any ship; and any active or inactive waste disposal site. For purposes of the definition, any building, structure, or installation that contains a loft used as a dwelling is not considered a residential structure, installation, or building. Any structure, installation or building that was previously subject to this subpart is not excluded, regardless of its current use or function."

"**Friable ACM**" means any material that contains more than one percent asbestos by weight, area, or volume, and when dry can be crumbled, pulverized, or reduced to powder by hand pressure. The term includes non-friable forms of asbestos after such previously non-friable material becomes damaged to the extent that when dry it can be crumbled, pulverized, or reduced to powder by hand pressure as determined in the field by a CABI.

"**General Abatement Contractor**" refers to State-certified entity contracted to perform asbestos contaminated soil disturbing activities in accordance with the standard operating procedure.

"**Geofabric**" means a permeable fabric or synthetic material used for both visual and physical separation.

"**Green Waste**" biodegradable waste that can be composed of garden or park waste, such as grass or flower cuttings and hedge trimmings, as well as domestic and commercial food waste.

"**Mechanical**" means operated or produced by mechanism, tool or machine. This may include but shall not be limited to, an excavator, backhoe, grader, tiller, auger, or hand shovel.

"**Non-regulated Asbestos Contaminated Soil**" **(Non-RACS)** means soil or debris that has been inspected by a CABI to contain only:

- Intact non-damaged, non-friable ACM(s).
- Damaged non-friable ACM(s) that do not have a high probability to release fibers based on the forces expected to act upon the material during disturbance as determined in the field by a CABI(s) through a "RACS Determination". The following ACM(s) are predetermined to be Non-RACS:
    - Resin-based materials including but not limited to phenolic-plastic (Bakelite), used in electrical and mechanical parts
    - Resilient flooring (vinyl, asphalt, rubber) excluding non-tar impregnated friable felt backing on sheet vinyl flooring (linoleum)
    - Tar-impregnated or asphaltic materials in good condition that have not become brittle
    - Elastic, pliable, or rubberized materials, including but not limited to:
        - Pliable duct sealant
        - Pliable fiberglass insulation sealant
        - Pliable fire-stop caulking /sealants
        - Pliable window and door caulking
    - Extremely hard materials, coatings and sealants including but not limited to:
        - Laboratory countertops and sinks
        - Epoxy-type Concrete Masonry Unit (CMU) coatings
        - Epoxy-type panel adhesive
        - Duct sealant
        - Ceiling tile adhesive
    - Other ACM(s) as approved by the Department at the request of the owner or person disturbing debris, to not have a high probability to release fibers.

"Suspect Debris" means non-soil debris that is Suspect, including ash, to contain ACM. This material requires a RACS determination by a CABI, and until the CABI determination is complete, will be assumed to be RACS and managed in accordance with this standard operating procedure. Although this material may not require special management as ACM, it may still require management as a solid waste. Co-mingled Suspect and Non-Suspect debris should be managed as Suspect Debris.

"Non-soil Debris" means materials entrained within the soil matrix that are not composed of soil. These may include Non-RACS, RACS, or Non-Suspect. Often associated with uncontrolled fill, or historical urban fill areas.

"**Project-specific Regulated Asbestos Contaminated Soil Management Plan**" (PSRMP) means a RACS management plan for a single project submitted in accordance with CSWR §5.5

"**Regulated Asbestos Contaminated Soil**" (RACS) means soil, ash or debris (plus six inches in all directions of surrounding soil or other matrix material) containing:

- Friable ACM as determined in the field by a CABI through a RACS determination; Previously non-friable ACM(s) that have been rendered friable as determined in the field by a CABI(s) through a RACS determination.
- Non-friable ACM(s) that have a high probability of releasing fibers based on the forces expected to act upon the material during soil disturbance as determined in the field by a CABI(s) through a RACS determination; deteriorated non-friable ACM(s) that are in poor condition resulting in a high probability to release fibers due to weathering, historical mechanical impact, fire damage (by evidence of ACM within an ash layer) or other factors as determined in the field by a CABI(s) through a RACS determination.
- The following broken, resized, or damaged ACM(s) are predetermined to be RACS:
    - Asbestos cement materials
    - Plaster
    - Brittle caulking, glazing and sealants
    - Powdery Concrete Masonry Unit (CMU) sealant
    - Powdery floor leveling compound
    - Drywall/wallboard and associated joint compound material
    - Firebrick
    - Other material as determined by the Department, at the request of the owner or person disturbing debris, to have a high probability to release fibers.
- Soil or ash known to contain non-visible asbestos based on documented evidence.

"**RACS Determination**" for the purpose of this standard operating procedure means a determination, conducted in the field by a Certified Asbestos Building Inspector (CABI), of the friability of Asbestos Containing Material (ACM) and the probability of non-friable ACM to release fibers based on the condition of the material and the forces that are expected to act on it during disturbance. Determinations of friability shall be based on the requirements for such determinations set forth in Air Quality Control Commission Regulation No. 8 (5 CCR 1001-10, Part B). Determinations of the probability for non-friable ACM to release fibers during disturbance shall be based on the following:

1) The condition of the material prior to disturbance, based on observations of weathering, the integrity of the material, historical mechanical impact, or fire damage;

2) The potential for the material to be broken, resized or damaged during planned disturbance;

3) The material shall be considered RACS if the planned disturbance includes any of the following:

a. Augers

b. Rotary style trenchers

c. Driving on ACM lying on the surface (vehicles or equipment)

d. Blasting or other detonation

e. Intentional burning

f. Other types of direct mechanical impact which are:

i. In direct contact with ACM or result in observation of ACM after disturbance, and

ii. Causing damage to the ACM

"**Regulated Work Area**" (RWA) means the portion(s) of a site at which soil disturbing activities involving RACS occur

"RACS Disturbance" means activities such as removal, management, or other physical disturbance of RACS

"**Soil-disturbing Activities**" means digging, excavating, staging, loading, stockpiling, backfilling, compacting, grading, tilling, drilling, intrusive sampling, and equipment or vehicle movement or any other mechanical activity, that when used, disturbs the surface and/or subsurface soil. Disturbance or removal of soil, or soil with debris and/or RACS is considered a soil-disturbing activity. Hand disturbance or removal of RACS is subject to the State Regulation and this standard operating procedure but is not considered to be a mechanical disturbance.

"Staging" means the accumulation of RACS in the RWA for twelve (12) hours or less.

"Stockpiling" means the accumulation of RACS that will exist for more than twelve hours, up to and including ten calendar days

"Storage" means the accumulation of RACS greater than ten days but not exceeding six months unless a longer timeframe is approved by the Department and DDPHE.

"**Visible Emissions**" means any airborne or liquid emissions, coming from, or having come into contact with RACS, which are visually detectable without the aid of instruments. Proper disposal of appropriately filtered decontamination water does not constitute a visible emission.

"**Visual Inspection**" means observation with sufficient proximity to identify discrete visible materials, while maintaining the safety of the inspector.

1. Introduction

The City and County of Denver (CCOD) recognizes the need for construction activities to have a well-established agreement in place regarding the risks from management of construction projects where soil may be impacted by asbestos-containing materials (ACMs). While these agreements modify traditional construction work practices and required personnel, they do remain consistent with the established Colorado Department of Public Health and Environmental (CDPHE) rules and regulations and current industry standards for the management of regulated asbestos-contaminated soil (RACS). Today's public safety realities are highlighted by the numerous construction projects that encounter RACS, and the need for CCOD and its construction partners to have established field standards that protect public health from exposure to asbestos, and help the projects stay on schedule and on budget. This document has been prepared to be used on CCOD's projects. Implementation of this standard operating procedure on other projects not owned or controlled by the CCOD are in no way the responsibility of the CCOD.

The Denver Department of Public Health and Environmental (DDPHE) and CDPHE have worked cooperatively to develop a solution designed to be followed by any contractor or its sub-contractor when performing soil-disturbing activities (as defined within this standard operating procedure) during excavation at CCOD's construction projects. Initially, the solution establishes standard operating procedures that are intended to be followed during construction projects where activities have disturbed and/or identified non-soil debris within the soil matrix. Additional standard operating procedures are predicated on the type and amount of non-soil debris and coordination with and the approval by the CCOD project manager.

Soil that is not to be disturbed by planned construction on a project will remain in-place. Characterization and remediation of soil not directly disturbed by project activities are beyond the scope of this standard operating procedure, unless specifically directed by DDPHE. If remedial actions are required, additional planning would be conducted under the direction of DDPHE.

1.1 Purpose

This standard operating procedure has been prepared to ensure compliance with the Colorado Solid Waste Regulations CCR 1007-2 Part 1, Section 5.5 (Colorado Solid Waste Regulation [CSWR] §5.5; CDPHE, 2014), and provides the procedures for identification, safe handling, transport, and disposal of Non-RACS or RACS that may be encountered during soil-disturbing activities. Provisions of CSWR §5.5, not specifically referenced within this standard operating procedure, must be followed; therefore, any contractor working on CCOD projects must be familiar with both this document, and CSWR §5.5. In the event of any disparity between the two, CSWR §5.5 will supersede provisions included within this document.

This standard operating procedure has been prepared to minimize potential delays, and to develop approved standard procedures that the contractor will implement as needed for future soil-disturbing where Non-RACS and RACS may be encountered. The quick disseminating of critical information to participating parties is key to the proper identification of debris, management of Non-RACS and RACS, and protection of public health and environment.

This standard operating procedure has been approved by the CDPHE (Appendix A) and incorporates by reference CDPHE Regulations Pertaining to Solid Waste Sites and Facilities (6 CCR 1007-2, Part 1), CSWR §5.5 - Management of Regulated Asbestos Contaminated Soils (CSWR §5.5). The Regulation can be found at: https://www.colorado.gov/pacific/cdphe/solid-waste-regulations.

1.2 Applicability

The requirements of CSWR §5.5 apply to the owner or operator of any property with RACS at which soil-disturbing activities are occurring or planned. The owner/operator may choose to follow the procedures set forth in CSWR §5.5.1(A) and (B) when debris is exposed or disturbed to determine if the debris is RACS. Soil-disturbing activities involving Non-RACS, where no RACS is present or generated, are not subject to the requirements of CSWR §5.5, but Non-RACS must be disposed as non-friable asbestos waste in accordance with the disposal requirements set forth in Section 5.2 of the CSWR, where applicable.

It is the responsibility of the general contractor (contractor), including the contractor's subcontractors, to incorporate this standard operating procedure into a project's scope for identifying debris or other environmental hazards and the subsequent management of that material according to this standard operating procedure and the Materials Management Plan (MMP) (if applicable). Unless otherwise written, separate from this standard operating procedure, it is the responsibility of the contractor to employ appropriate personnel capable of meeting the requirements of this standard operating procedure and CSWR §5.5 during identification and management of all debris and RACS.

Prior to commencing soil-disturbing activities, if there is no visible or documented evidence, such as construction drawings or analytical reports or environmental investigations, of RACS during a soil-disturbing action, the contractor does not have a duty under this standard operating procedure or CSWR §5.5 to sample or otherwise investigate for RACS. However, if RACS or suspect RACS is discovered, the contractor is obligated to follow this standard operating procedure.

This standard operating procedure may be incorporated within a MMP and/or Health and Safety Plan for site-specific safe work practices. Should either of those plans or other site-specific environmental work plans require changes to this standard operating procedure, the contractor shall present a written draft amendment to be reviewed by the CCOD Project Manager (who will coordinate with DDPHE) prior to submittal for review and approval by CDPHE.

1.3 Non-RACS vs. RACS

As described in CSWR §5.5 (and the definitions presented in this standard operating procedure):

- Non-RACS is soil or debris that contains intact, non-damaged ACM, or damaged non-friable ACM that does not have a high probability to release fibers as determined by a Certified Asbestos Building Inspector (CABI) (note, additional description provided in the definitions).
- RACS is soil, ash, or debris (plus 6 inches in all directions) containing friable ACM, non-friable ACM that has been rendered friable, or deteriorated ACM that has a high potential to release fibers due to weathering or other processes (note, additional description provided in the definitions).

Essentially, Non-RACS material contains ACM that is unlikely to release asbestos fibers, and RACS is material that contains ACM that is likely to release asbestos fibers. Although Non-RACS is technically not subject to the provisions of CSWR §5.5, disposal requirements still apply per CSWR §5.2. Further, the presence of Non-RACS still requires special attention during management activities, as there is a high potential that RACS and Non-RACS may be co-located at a project, or that management activities may result in Non-RACS releasing asbestos fibers, and thus transforming into RACS.

1.4 Project-specific Regulated Asbestos Contaminated Soil Management Plan

As determined by DDPHE, a Project-specific Regulated Asbestos Contaminated Soil Management Plan (PSRMP) may be prepared for individual projects; the PSRMP would detail project-specific RACS management protocols, amended best management practices (BMPs), or other applicable changes to this standard operating procedure. If DDPHE determines that a PSRMP is necessary, the PSRMP would be reviewed and approved by DDPHE then CDPHE, and management techniques may supplant those presented in this standard operating procedure. At a minimum, this standard operating procedure should be utilized a foundation for the PSRMP.

1.5 Key Parties and Responsibilities

The following table provides contact and general responsibility information for key parties. A full contacts list may not be established at the beginning of every project. In cases where RACS management will be needed, contact information shall be amended as required.

Table 1 Key Parties and Responsibilities

Party	Contact	Responsibility
CDPHE	Brian Long Phone: 303-691-4033 Email: briant.long@state.co.us	Regulatory Agency – State of Colorado
CCOD – DDPHE	Steve Gonzales Phone: 720-865-5447 Email: steve.gonzales@denvergov.org If no immediate response, call 720-460-1706	Environmental Quality Technical Oversight – City and County of Denver
CCOD Project Manager	TBD	Overall project management of CCOD Project
Contractor	TBD	General Construction; RACS Management
Specialized Abatement Contractor (if applicable)	TBD	RACS Management
Environmental Consultant (CABI, AMS)	TBD	CABI, RACS Oversight and if necessary Air Monitoring Specialist (AMS); discovery notification to CCOD Project Manager and DDPHE, and to CDPHE if approved by DDPHE

Responsibilities for key personnel are summarized in Table 2, and discussed in detail in the standard operating procedures. Key personnel will be contacted as required, as described in the text of the standard operating procedure.

Table 2 Responsibilities

Duties per Standard Operation Procedure	Project Personnel				
	Contractor	Sub-contractors	CABI	Air Monitoring Specialist (AMS)	GAC
Provide Awareness Training			☒		
Receive annual RACS Awareness Training (All Site Personnel)	☒	☒			☒
Receive Project-Specific Annual Asbestos Awareness Training (to enter any Regulated Work Area [RWA] during RACS disturbance)	☒	☒	☒	☒	☒
Environmental Consultant Responsibilities			☒	☒	
Handling, Disturbing, Removing RACS	☒	☒	☒	☒	☒
Decontamination of Equipment, Personal Protective Equipment (PPE) and RWA			☒	☒	☒
Wind Speed Monitoring			☒	☒	
Air Monitoring				☒	
Documentation	☒	☒	☒	☒	☒

2. Process Flow and Decision Scenarios

The following process flow and corresponding figures present the more likely scenarios related to the discovery of debris and management of RACS for CCOD's projects, and the decisions to be made for conducting continued soil-disturbing activities under these discovered conditions. Note that these scenarios are general. Each RACS discovery and project is unique, so the actual steps necessary to reasonably respond to a RACS discovery and management may change. Coordination with DDPHE on the most practical management strategy is required when there is reason to believe that RACS is present or is identified.

2.1 Scenarios

This standard operating procedure has been prepared to provide guidance for five soil-disturbing scenarios, which are described in detail below.

2.1.1 Excavation in Areas with No Debris

This scenario applies when soil disturbance is planned and there are no RACS concerns (e.g., soil that is "clean" with no visible debris) (**Figure 1**). This scenario applies where the contractor has been provided information from the CCOD Project Manager, or has determined for himself, that the project area is not likely to have RACS or Non-RACS present because, through visible inspection or other research, no debris is present. The contractor will then proceed with work as planned, but must be familiar with this standard operating procedure, and must be observant regarding unexpected debris discovery.

2.1.2 Excavation in Areas with Non-Suspect Debris

This scenario applies when soil disturbance would occur in areas where Non-Suspect Debris is present [e.g., soil containing pieces of clean concrete (with no associated or attached materials)], but when no Suspect Debris has been identified (**Figure 2**). In this standard operating procedure, the contractor is empowered to make this determination himself. However, if the contractor is unsure of the nature of debris, a CABI should be consulted to provided certainty of the debris identified. Additional information about the classification of debris is presented in detail in Section 4.

2.1.3 Discovery of Suspect Debris or Suspect RACS During Excavation

This scenario applies when soil disturbance occurs where Suspect Debris, including RACS, is suspected or encountered unexpectedly (e.g., work within a known historical urban fill area [https://www.denvergov.org/opendata/dataset/city-and-county-of-denver-historical-fill-areas] (**Figure 3**). There are many areas in the CCOD where uncontrolled fill is present in the subsurface, including historical urban fills, areas where buildings once stood but have since been demolished, areas where

channelization along streams and rivers occurred or where floodplains or gravel pits were filled, or where heavy industries were once present. A key component of discovery is to: conduct interim actions that are described in this standard operating procedure in detail; contact a CABI to make a RACS determination; and, coordinate stabilization, removal actions and required documentation.

2.1.4 Excavation in Areas with Known RACS

This scenario applies where soil disturbance is planned in an area where known RACS is present (as confirmed through prior investigation or via a RACS determination by a CABI) (**Figure 4**). In this scenario, careful planning would be conducted to perform management actions in accordance with this standard operating procedure and CSWR §5.5.

2.1.5 Subsurface Investigations

This scenario applies when soil disturbance is conducted related to subsurface investigations, including environmental, geotechnical or utilities (**Figure 5**). These investigations are generally small in scale, where a drill rig may be used to drill a small-diameter hole to evaluate geologic conditions; a small test pit/trench is excavated to visually assess subsurface conditions (primarily in the investigation of Suspect Debris conditions); or a vacuum truck/water knife is used to locate a utility line. Detailed analysis of the RACS management strategies are presented in Section 5.1.5 of this standard operating procedure. **Note, if a utility investigation utilizing a vacuum truck/water knife is proposed in a known historical urban fill site and/or area with known RACS or Suspect Debris, additional project-specific planning will be necessary BEFORE work is initiated as there is a high potential that equipment may become contaminated. Coordination with DDPHE will be required.**

Figure 1 Excavation in Areas with No Debris

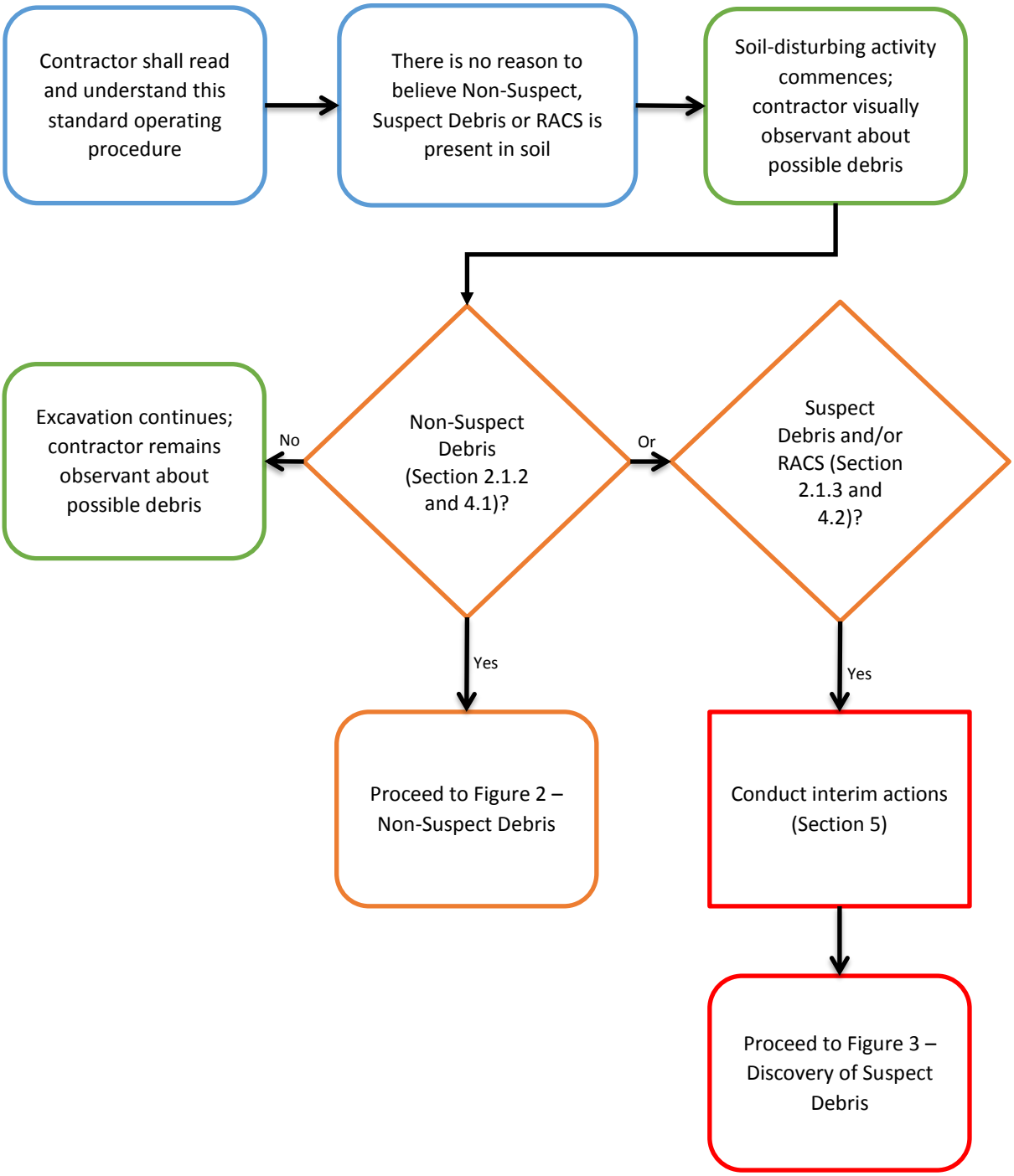


Figure 2 Excavation in Areas with Non-Suspect Debris

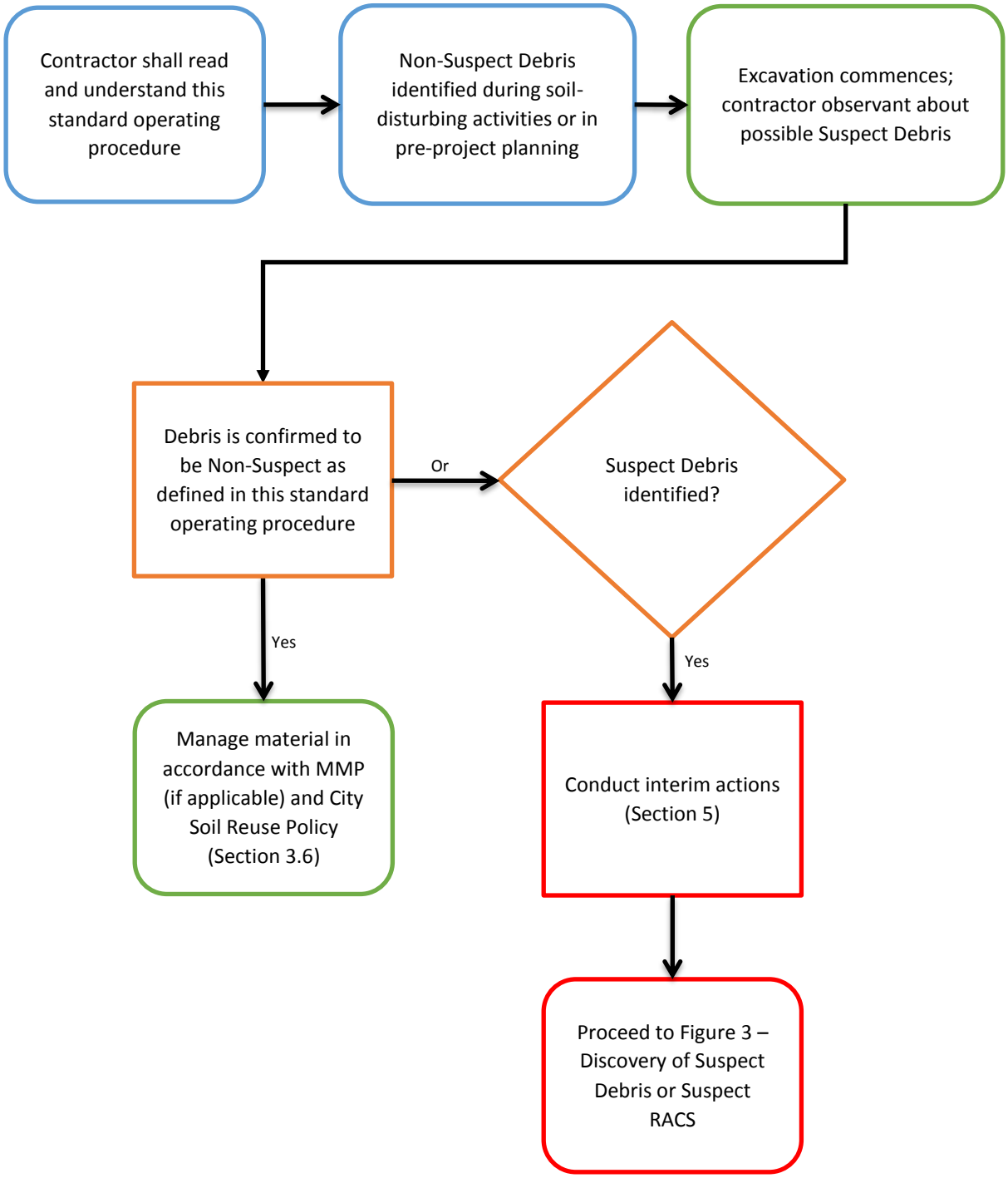


Figure 3 Discovery of Suspect Debris or Suspect RACS During Excavation

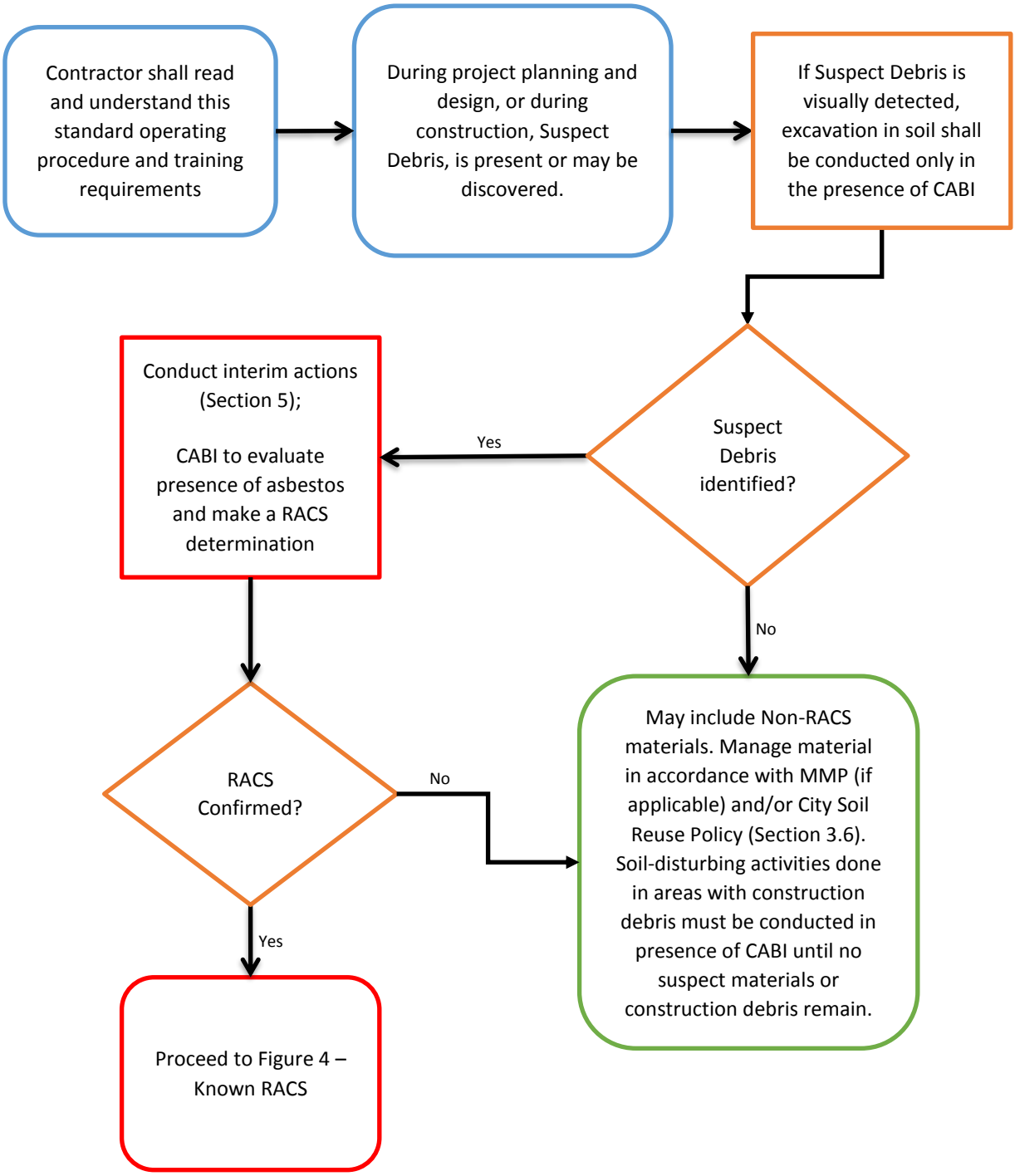


Figure 4 Excavation in Areas with Known RACS

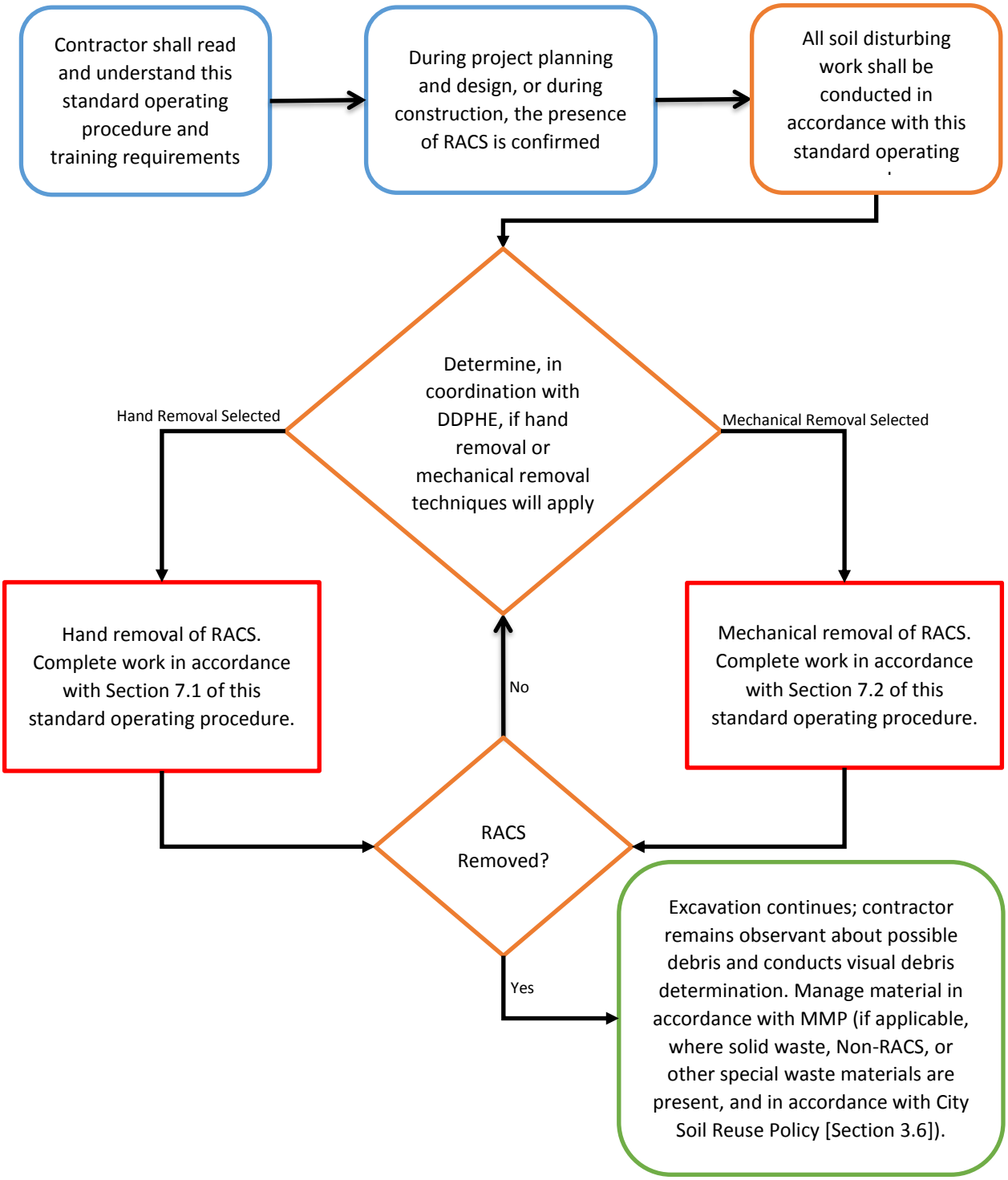
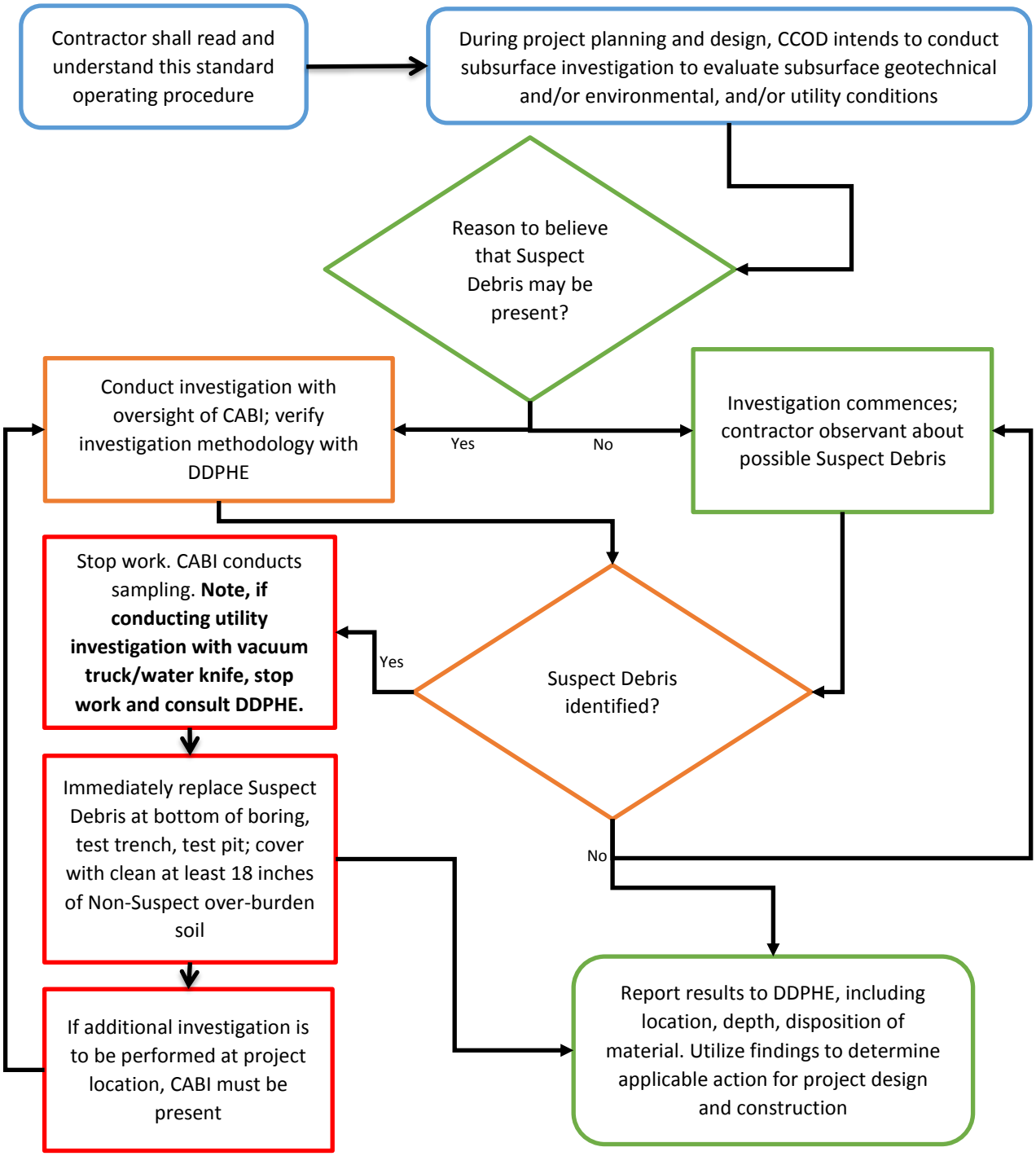


Figure 5 Subsurface Investigations



3. General Requirements

The following sections describe general requirements for the management of RACS.

3.1 Training for Site Personnel

As described in CSWR §5.5.3, personnel overseeing, directing, inspecting, and/or handling RACS (including suspect asbestos) and all personnel inside the Regulated Work Area (RWA) during the disturbance of RACS, shall have annual asbestos awareness training, and provide documentation to the CABI.

Personnel who enter the RWA during disturbance of RACS will receive project-specific training by a CABI familiar with this standard operating procedure and CSWR §5.5, as well as the project. This includes drivers of trucks carrying contaminated material for off-site disposal. The training will cover the provisions of this standard operating procedure, as well as the following:

- Background of asbestos, including health effects
- Overview of the requirements of CSWR §5.5 and this standard operating procedure and its implementation
- Recognition of Suspect Debris that may contain asbestos and which requires further evaluation by a CABI
- Overview of Non-Suspect Debris, Suspect Debris, RACS, and Non-RACS, and standard operating procedure protocols for each
- Controls and notifications to be followed when debris that may contain asbestos is encountered
- The nature of operations that could result in exposure to asbestos fibers
- Spill prevention and contamination reduction techniques
- Proper use, handling, and disposal of PPE
- Respiratory protection levels required for various activities and conditions
- Engineering controls and other measures to prevent contact with contaminants
- Engineering controls to prevent visible emissions from leaving the RWA
- Personnel and equipment decontamination and the establishment of decontamination stations
- Emergency procedures

- Project chain-of command and identification of authorized personnel with stop-work authority
- Hands-on training specific to the soil-disturbing activities the individual will be performing subject to CSWR §5.5.

Records of this training will be retained by the CABI, and will be available for inspection for the duration of the project for which the training is conducted.

3.2 Health and Safety

There is a potential for increased risk to the health of workers during disturbance/removal of RACS. Awareness by site personnel of these hazards is of the highest priority. Therefore, a site-specific Health and Safety Plan will be developed by the contractor prior to any RACS management. Site personnel will be provided with a copy of the Health and Safety Plan for review, and will be required to sign a form stating that they are aware of, agree to, and understand the requirements of the plan. The contractor will be required to employ the proper personnel, and PPE, to provide a safe working environment for its employees, consultants and subcontractors.

3.3 CABI and AMS Requirements

When a *Discovery of Unknown Suspect Debris or Suspect RACS,* or *Known RACS* is present, a CABI who meets the training, certification, and experience requirements of CSWR § 5.5.3(D) (and an Air Monitoring Specialist [AMS] if a RWA is required) shall be on-site on a full-time basis during all soil-disturbing activities, to physically observe and monitor the air and site conditions and provide information to the contractor to help limit and avoid asbestos fiber release. The CABI and AMS can be the same person if she/he meets the CABI and AMS requirements listed below. Ideally, the CABI and AMS will be the same person. Depending on site conditions and scope, more than one CABI, AMS, or both may be required.

When a *Discovery of Suspect Debris or Suspect RACS,* or *Known RACS,* is present, the CABI(s) will be responsible for the following:

- Have all current applicable training certificates and State of Colorado Certification(s) in accordance with the CDPHE-Air Quality Control Commission (AQCD Reg. 8) and Hazardous Materials and Waste Management (HMWMD) regulations to be a CABI (CSWR § 5.5.3 (D)).
- Be on-site on a full-time basis and continuously observe all soil disturbing, excavation, and loading activities.
- Identify if suspect RACS is present.
- Complete necessary sampling of suspect asbestos, and make RACS determination(s).

- Complete CABI Work Day Documentation Form (Appendix B), thoroughly detailing site activities as presented in Section 8 – Close Out Report.
- Maintain all pertinent documentation related to adherence of the standard operating procedure, including sampling results, air monitoring data, waste manifests, photographs, etc.
- Inspect the RWA and equipment after removal of RACS to evaluate whether remaining ACM is present on the surface or on equipment.
- The CABI will have "Stop Work" authority if it is believed that work is being performed outside the guidelines of this standard operating procedure or of CSWR §5.5, or if actions harmful to life and health, or the environment, are observed; the CABI will not be responsible for consequential damages for any work stoppage, including real or perceived harm, including lost productivity, that may result.
- Notification of RACS disturbance to CDPHE on behalf of the contractor.
- Updates to CCOD Project Manager and CDPHE on contractor decisions regarding RACS management.
- Notification of deviations from this standard operating procedure to the CDPHE (note: deviations from this standard operating procedure and/or CSWR §5.5 will require approval by DDPHE and CDPHE; deviations may be addressed through preparation of an amendment to this standard operating procedure, PSRMP, or other means as approved).
- Monitor and log wind speed and direction during soil disturbing activities.

If RACS management is required by Section 7.2.5 of this standard operating procedure or CSWR §5.5, the AMS(s) will be responsible for the following:

- Have all current applicable training certificates and State of Colorado Certifications in accordance with the CDPHE-AQCD regulations to be an AMS (Air Quality Control Commission Regulation No. 8 (5 CCR 1001-10, Part B).
- Be on site on a full-time basis during disturbance, excavation, and loading of RACS.
- Monitor RWA during removal and disposal of RACS for compliance of this plan.
- Place and monitor air samples on site and around RWA during soil-disturbing activities.
- Monitor and log wind speed and direction during soil disturbing activities.
- The AMS will have "Stop Work" authority if it is believed that work is being performed outside the guidelines of this plan or of CSWR §5.5, or if actions harmful to life and health, or the environment, are observed; the AMS will not be responsible for consequential

damages for any work stoppage, including real or perceived harm, including lost productivity, that may result.

- Submitting an Emission Control Plan for each detection of asbestos by TEM analysis as required by CDPHE in accordance with CSWR § 5.5.7 (E)(2)(f)(i)(ii) & (iii).

3.4 Contractor Requirements

The following contains requirements for the contractor performing RACS disturbance/removal:

- The contractor shall provide documentation to the CABI and CCOD that all individuals performing RACS-disturbing activities have completed a project-specific awareness training that provides information necessary to perform their duties in a way that ensures compliance with the requirements of the CSWR §5.5. If the contractor cannot provide this documentation, then the applicable training will be conducted by the CABI.
- The contractor shall ensure that individuals performing RACS-disturbing activities have completed asbestos awareness training in accordance with Occupation, Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1926.1101(k) Communication of Hazards - (9)(10) .
- Records that document the training, experience, or certification requirements in CSWR §5.5. Documents shall be available on-site for review throughout the duration of soil-disturbing activities.
- The contractor will be required to prepare and implement a Health and Safety Plan in accordance with the applicable regulations, including OSHA. The contractor will be responsible for the health and safety of its employees, subcontractors, consultants, etc., as well as provide all necessary training and PPE for completion of work.
- The contractor will be responsible for maintaining all necessary site controls to prevent unauthorized entry into the RWA in accordance with Section 5.2 of this standard operating procedure, and with CSWR § 5.5.7(A) “Establishment and Control of a Regulated Work Area (RWA)”.
- The contractor will be responsible for adherence to this plan at the direction of the CABI/AMS. The CABI/AMS will be completing air monitoring in accordance with Section 7.2.5. Based on the air monitoring results, the CABI/AMS will direct the contractor to institute additional BMPs, if necessary, to eliminate fugitive dust emissions or visible emissions.

The following contains requirements for the contractor performing any soil disturbing activity:

3.5 Notifications

The Notification of RACS Disturbance form (Appendix C) must be submitted to CDPHE prior to commencing work in planned RACS management or within twenty-four (24) hours of unexpected discovery of RACS areas. The notification shall indicate which management approach will be utilized per the project's soil-disturbing scenario as presented in Section 2 of this standard operating procedure:

- Use this standard operating procedure (and note what, if any, deviations are proposed [with DDPHE approval]); or
- A project-specific PSRMP (with DDPHE approval); or
- Standard Requirements of CSWR §5.5 (with DDPHE approval).

Planned RACS disturbance shall not commence until approval has been granted by CDPHE. Notification must have the approval of the CCOD Project Manager and DDPHE must be notified before any notification is submitted to CDPHE. Notification is not required when only sampling debris for ACM content by a CABI.

For all soil-disturbing activities where the contractor or subcontractor will perform RACS management:

- Within twenty-four (24) hours of **unplanned** RACS discovery, the contractor or CABI shall submit a Notification of RACS Disturbance form (Appendix C) to CDPHE indicting that the project will be using the RACS management steps as detailed in this standard operating procedure.
- Ten (10) days prior to start of RACS disturbance for **planned** RACS management, the contractor or CABI, shall submit a Notification of RACS Disturbance form (Appendix C) to CDPHE indicting that the project will be using the RACS management steps as detailed in this standard operating procedure.
- Notification of RACS Disturbance form shall be emailed to CDPHE address on the form, and copied to the CCOD Project Manager and DDPHE contact.
- Maps, figures, drawings, or other applicable information shall be included with the Notification of RACS Disturbance form.
- In the event of an emergency (a condition which is immediately dangerous to life or property; e.g., broken water main, broken gas line) in which a soil-disturbing activity must continue or commence at once, notification shall be made as soon as possible, but within 24 hours of identifying or assuming the presence of RACS within the soil-disturbing area. During the initial response to the immediate emergency, the standard requirements of RACS management in accordance this standard operating procedure shall be implemented to the extent possible. Within 48 hours, any disturbed and/or exposed RACS shall be managed in accordance with this standard operating procedure.

- RACS management must be approved by the CCOD Project Manager prior to commencing ongoing soil-disturbing activities involving RACS. Exceptions would be RACS inspection, stabilization, and necessary decontamination activities. Any planned changes to this standard operating procedure must be approved by the CCOD Project Manager, DDPHE, and CDPHE prior to commencing RACS disturbance activity.

3.6 Soil Reuse

In some circumstances, an MMP will be prepared for a project. Soil reuse, and management of soil not impacted by RACS, should be followed in accordance with the MMP. If an MMP is not available, coordination with DDPHE, and potentially CDPHE, may be necessary. Regardless, all CCOD projects must follow the DDPHE *Guidance for Reuse of Soil on City Projects*. Some general requirements (but not all requirements) are described as follows:

- If the soil generated at a project would be reused at a third-party property, coordination with DDPHE will be required, as well as other requirements noted in the *Guidance for Reuse of Soil on City Project,* which define soil quality and analytical requirements.
- Soil that is proposed for reuse at a CCOD-owned park must meet the requirements defined for Unrestricted Reuse, and cannot contain any debris (Suspect or Non-Suspect).
- Soil that is not to be disturbed by planned construction on the project will remain in-place, regardless of its reuse classification. Characterization and remediation of soil not directly disturbed by project activities are beyond the scope of this standard operating procedure, unless specifically directed by DDPHE. If remedial actions are required, additional planning would be conducted under the direction of DDPHE.
- No debris (including Non-Suspect), RACS, or impacted soil may be left exposed at final grade surfaces. Depending on the conditions discovered, it may be necessary to over-excavate these materials 12 inches or more (18 inches minimum if RACS is present), and backfill with clean soil to the final grade (see Section 5.1 of this standard operating procedure).
- **No soil containing debris, whether Suspect or Non-Suspect, may be reused onsite or off-site.** There may be certain circumstance where approval may be obtained, but only through coordination with DDPHE, and possibly with CDPHE, in accordance with applicable regulations.
- All soil destined for landfill disposal, including RACS managed according to this standard operating procedure, must be disposed under proper waste characterization and waste profiling procedures at the Denver-Arapahoe Disposal Site.

4. Debris Identification

The contractor and/or sub-contractor(s) to the contractor, while performing soil-disturbing activities under this standard operating procedure, shall have the responsibility of inspecting all soil-disturbing activities through continuous visual inspection for the presence of Suspect Debris or Non-Suspect Debris. All visible debris will have a debris determination as **non-suspect for ACM** (Non-Suspect), or **suspect for ACM** (Suspect). The contractor/sub-contractor shall follow the directions given in this standard operating procedure related to findings and debris classifications. If the contractor/sub-contractor is unsure of a classification or unable to make this classification, the contractor/sub-contractor shall contact a CABI to assist in the final classification of soil and/or debris, or contact DDPHE.

The contractor and/or sub-contractor shall evaluate any debris encountered to see if it meets the parameters of Section 4.1 of this SOP and CSWR § 5.5.2 (H) & (I) during all soil-disturbing activities. To ensure an accurate evaluation is made, any contractor and/or sub-contractor performing any soil-disturbing activities while operating under the provisions of this SOP and not identified as a General Abatement Contractor, shall be required to have all project field personnel complete a general RACS awareness training as detailed in CSWR § 5.5.3 (A) annually. This training is required to be presented by a CABI that meets the training and experience requirements of section CSWR § 5.5.3 (D) and will specifically address all necessary protocols and actions for debris identification regarding sections 4.1 and 4.2 of this SOP. Furthermore, the contractor and/or sub-contractor shall document their debris evaluation(s) and debris encounters(s). Debris documentation and training records shall be made available at upon request by CCOD and/or CDPHE.

4.1 Debris Classified as Non-Suspect for ACM

Materials will be defined as **non-suspect for ACM** when it meets the following criteria:

- The material is soil only, where there are no visible signs of construction debris at the point of soil disturbance; or
- Soil that contains the following non-suspect debris:
  - Metal - with NO associated materials on it (e.g. sealants, insulation, adhesives, etc.)
  - Glass - with NO associated materials on it (e.g. caulking, glazing, sealants, etc.)
  - Plastic - with NO associated materials on it (e.g. sealants, adhesives, etc.)
  - Wood - with NO associated materials on it (eg. drywall, plaster, adhesives, caulking, etc.)
  - Concrete - bare, with NO associated materials on it (e.g sealants, adhesives, waterproofing, tars, floor tiles, etc.)
  - Plant material, including plant wastes from the food processing industry and vegetative food waste
  - Yard trimmings

- Untreated wood wastes
- Non-industrial and non-insulative paper products (e.g., newspaper, magazines, food wrappers)
- Debris that has been evaluated during a project-specific subsurface investigation, and has been determined by a CABI as Non-Suspect (documentation must be maintained on the project at all times); special caution is recommended, as subsurface conditions in areas where filling has been conducted can be highly variable, and unexpected discoveries may be identified
- Or other material as approved by CDPHE

4.2 Debris Classified as Suspect for ACM

The contractor shall classify all other debris types not specifically listed as non-suspect for ACM above, as **suspect for ACM**, and therefore must have a RACS determination completed by a CABI following the definitions sections of this standard operating procedure and CSWR §5.5, or be assumed to be RACS and managed in accordance with this standard operating procedure (with approval from DDPHE).

Soil or ash known to contain non-visible asbestos fibers, based on documented evidence such as construction drawings or analytical reports, is RACS, and if exposed during a soil-disturbing action, shall be managed in accordance with this standard operating procedure.

Because ash can contain burnt building debris that contains asbestos materials, it is automatically assumed to be RACS. However, it can be evaluated by a CABI (including through laboratory analysis), to be non-ACM during the RACS determination.

5. Initial Actions and Stabilization for RACS Discovery

This section describes the immediate and interim actions that will be implemented by the contractor if he identifies debris that is classified as **suspect for ACM**. When Suspect Debris is discovered during soil-disturbing activities, the critical requirements are: 1) **avoid generating dust and avoid being in direct contact with airborne soil emissions**, thereby limiting potential exposure to asbestos fibers; and 2) **stabilize the discovery**. Each Suspect Debris encounter scenario will vary; however, the following general processes must be followed:

- Stop all soil-disturbing activities around the discovery until a CABI's RACS determination can be made that has been reviewed by DDPHE.
- Remove all contractor personnel out of the Suspected Debris area.
- Contact DDPHE, and CCOD Project Manager, of the discovery to coordinate next steps.
- A layer of 6-millimeter (mil) polyethylene (poly) sheeting may be used to prevent cross-contamination onto clean soils during initial characterization activities by placing the poly on the ground and then placing the potentially contaminated soil, which has been adequately wetted, directly on the poly.
- Poly will be used to cover the suspect materials to prevent cross-contamination and spreading; care should be taken to make sure the poly will remain attached to the ground, even in high-wind conditions.
- Wet the area immediately surrounding the suspect RACS with water, prior to performing sampling activities that disturb the material (note: visual inspection does not require wetting). Maintain wet conditions throughout sampling activities.
- Isolate the area where the discovery has been made to prevent worker or public exposure and cross-contamination. It may be necessary install fencing or other measures to preclude such access.
- Coordinate with CABI to perform a RACS determination within 24 hours.
- The CABI will evaluate if personnel decontamination is required and advise accordingly.
- The CABI should evaluate equipment for the need for decontamination, and advise accordingly.
- The CABI will collect samples of the suspect RACS according to procedures provided in this standard operating procedure (Section 6).
- If leaving the site unattended, cover the disturbed soil with a layer of 6-mil poly sheeting, or spray with magnesium chloride solution (or equivalent) in sufficient amounts to adequately

wet the soil to prevent dust generation. The contractor shall implement control mechanisms to prevent unauthorized or unintended contact with the material (e.g., install fencing).

- After confirmation of RACS by the CABI, the CABI, in coordination with DDPHE, will direct the contractor on proper implementation of this standard operating procedure.

5.1 Temporary Stabilization Procedures

Any contractor who exposes RACS during a soil-disturbing activity, but does not disturb or come into contact with the RACS debris, such as a side-wall or bottom of excavation, and determines to have the RACS remain in place, shall have it covered or stabilized using one of the following methods:

5.1.1 Horizontal Excavation Faces (Excavation Floors)

- Cover RACS with geofabric, followed by eighteen (18) inches of fill suitable for unrestricted use, and vegetation; or
- Cover RACS with geofabric, followed by six (6) inches of fill suitable for unrestricted use, and concrete or asphalt.

5.1.2 Vertical Excavation Faces (Excavation Side Walls or Trenches)

- Cover RACS with geofabric, followed by fill suitable for unrestricted use to grade or six (6) inches, whichever is greater; or
- Alternate cover designs as approved by the CCOD Project Manager and CDPHE.

5.1.3 Standard Requirements for Temporary Sub-Surface Stabilization of RACS.

Any contractor who excavates RACS during a soil-disturbing activity, where it is decided that RACS will be put back into place for a future planned RACS removal not to exceed six (6) months, shall comply with the following

- RACS may only be placed within the Area of Contamination (AOC) that it was originally removed from; and
- Placement and stabilization of RACS shall utilize standard RACS management requirements in accordance with Section 5.1.1 of this standard operating procedure; and
- Provide DDPHE with a plan to coordinate with the CDPHE on how DDPHE/CCOD will track the 6-month time storage of RACS.

5.1.4 Standard Requirements for Permanent Stabilization of RACS

Except as provided in Section 5.5.1(D)(5) of CSWR §5.5, a contractor who disturbs or exposes RACS shall make the decision upon the initial discovery of RACS to either manage the RACS in accordance with Section 7 of this standard operating procedure, or cease soil-disturbing activities and permanently stabilize the disturbed or exposed RACS to control the release of asbestos fibers in accordance with one of the following:

- Cover RACS with geofabric, or equivalent visible and physical barrier, and restore the site to pre-disturbance conditions using fill suitable for unrestricted use; or
- Cover RACS with geofabric, or other equivalent visible and physical barrier, followed by eighteen (18) inches of fill suitable for unrestricted use, and vegetation; or
- Cover RACS with geofabric, or other equivalent visible and physical barrier, followed by six (6) inches of fill suitable for unrestricted use, and concrete or asphalt; or
- Cover RACS with geofabric, or other equivalent visible and physical barrier, followed by fill suitable for unrestricted use to grade for vertical excavation faces or trenches; or
- Alternate cover designs as approved by CDPHE.
- Determinations as to what materials would constitute an equivalent visible and physical barrier replacing geofabric shall be made through consultation with DDPHE and CDPHE.

All procedures shall follow standard requirements for RACS management as per Section 7 of this standard operating procedure.

5.1.5 Standard Requirements to Stabilize Investigation-Derived Waste

During the process of investigating or examining subsurface conditions during project design, Suspect Debris (debris classified as suspect for ACM) may be found. Investigations may include: geotechnical or environmental investigations (generally using continuous-flight augers advanced by a truck-mounted drill rig); environmental investigations utilizing excavated test pits or test trenches, utilizing an excavator or backhoe; or utility investigations using a water knife and vacuum truck to locate buried utilities. After investigation or examination, the soil generated during the investigation may be placed back into the subsurface area of origination (e.g., soil boring or test pit from which the material came). The following provisions shall apply:

- Subsurface Suspect Debris locations will be documented and can be made available to CDPHE upon request.
- Only soil generated during the subsurface investigation, at the location of origination, may be placed back into the subsurface.

- Upon discovery of Suspect Debris, drilling or excavation activities will cease. If a CABI is present, the material will be sampled, and the remaining Suspect Debris will then be placed directly back into the point of origination, at the deepest depth as practicable.
- Suspect Debris shall be placed at the bottom of the excavation (boring or test pit), and then covered with clean over-burden soil. At least 12 inches of clean soil must cover Suspect Debris. If a CABI is not present when suspect material is first identified, investigation and replacement of soil may not continue until a CABI is present for the remainder of investigation.
- In lieu of stabilization, Suspect Debris and the surrounding 12 inches of soil can be removed, and then managed and disposed as RACS in accordance with this standard operating procedure.
- **If a utility investigation utilizing a vacuum truck/water knife is proposed in a known historical urban fill site and/or area with known RACS or Suspect Debris, additional project-specific planning will be necessary BEFORE work is initiated as there is a high potential that equipment may become contaminated. Coordination with DDPHE will be required.**
- The contractor completing the investigation work must report to DDPHE Suspect Debris discoveries, including the location, depth, and disposition of the material. These findings will be used to determine applicable actions during the implementation/construction of the project.
- No additional stabilization or management of Suspect Debris, including RACS if confirmed, is required after these steps have been completed.
- The CABI will evaluate the need to decontaminate personnel and/or equipment, and advise accordingly.
- Information collected during the investigation shall be made available to the CCOD Project Manager and DDPHE, who will consider design strategies during the project design to avoid, minimize, or mitigate (via this standard operating procedure) RACS during project construction.
- Notification to the CDPHE of an unexpected discovery is required if stabilization procedures and documentation to DDPHE are performed in accordance with this standard operating procedure.

5.2 Site Access Control

The contractor will be responsible for maintaining effective project access control by establishing and taking measures to prevent access to the RWA (or areas where discoveries have been made and are being evaluated) by unauthorized persons. A fence should be erected around the perimeter of the project area to limit access to the site. Instances of unauthorized access not under the control of the contractor shall be evaluated to determine if additional access controls are warranted. The unauthorized access, and the response actions taken, shall be documented and provided to the CDPHE within 48 hours of the incident. Access will be limited to individuals that are approved to be on site.

If RACS is encountered/confirmed, the contactor will install proper signage stating the area is a RWA because of the presence of asbestos, and that the area is off-limits to unauthorized personnel. Personnel working on the site shall be advised and directed not to disturb areas where suspected or known asbestos is encountered. Personnel driving onto the site shall be notified of suspect or known asbestos locations and directed to not drive on or disturb those areas. At no time will vehicle traffic be allowed on surfaces where samples have shown positive test results, or where visible asbestos is present, or where untested suspect materials are located. This excludes equipment that is to remain off the road and on the project area for removal operations. Project equipment/vehicles moving across contaminated soils must do so in a way as to not generate visible emissions, and the soil shall be wetted to control visible emissions. Equipment/vehicles that come into contact with RACS will require decontamination as per section 7.2.7 of this standard operating procedure.

6. Suspect Asbestos Bulk Sampling

If Suspect Debris (which is suspect for ACM) is visually identified, the following steps will be applied to sample and analyze potential ACM by the CABI (only a CABI who meets the requirements discussed in Section 3.3 of this standard operating procedure may collect samples to determine asbestos content). Additional information is presented in Appendix D (CSWR §5.5 – Appendix 5A). All sampling and analysis shall be conducted in accordance with CSWR §5.5 – Appendix 5A.

- Samples of suspect asbestos material will be placed in appropriate sample containers such as sample bags or jars.
- Care should be taken to ensure that suspect asbestos material is adequately wetted to prevent visible emissions during the sampling process.
- Bulk samples shall be collected by homogenous type based on color, pattern, texture, thickness, associated materials, or by other identifying characteristics.
- The quantity and location of a suspect material shall be used to determine the number of bulk samples required to characterize the asbestos content of each homogeneous suspect material. For the purpose of determining that a homogeneous suspect material does not contain asbestos:
    - A minimum of three bulk samples shall be collected from the homogeneous material, unless there is insufficient material to constitute three samples.
    - If one of the collected samples of a homogeneous bulk material is determined to be ACM, then the homogeneous material shall be considered ACM.
- A field sampling form or log book entry will be maintained for each sample obtained. The form or log book entry will include the location using a hand-held global positioning system (GPS) instrument, date and time of each sample, depth below the ground surface the sample was identified, description of the type of material, assessment of friability of the material, and other observations made.
- Proper chain-of-custody procedures will be followed for all samples collected.
- Samples of newly discovered suspect asbestos materials will be analyzed by a National Voluntary Laboratory Accreditation Program (NVLAP)-accredited laboratory by Polarized Light Microscopy (PLM) methodology to determine if any asbestos fibers are present.
- Suspect materials not sampled according to these procedures must be assumed to be ACM and managed as such.

7. RACS Management

Through coordination with the CCOD Project Manager and DDPHE, the contractor may be retained to conduct RACS management. CCOD will require that the contractor, in coordination with the CABI/AMS, utilize management strategies that are protective of human health and the environment, meet the CSWR §5.5 requirements, and provide the best value to the CCOD. A detailed scope of work detailing how this standard operating procedure will be implemented, including costs, will be required prior to initiating RACS management.

A specialized asbestos abatement contractor may also be retained to conduct these services. Any entity who wishes to engage in RACS management must understand the intricacies of the CSWR §5.5 regulation, the materials, the risks, and management of the material. Due to the complexity of the work, it is highly encouraged that only experienced contractors conduct RACS management activities. The CCOD Project Manager and DDPHE will evaluate the experience and qualifications of the contractor conducting RACS management prior to implementing RACS management on a project through review of the detailed scope of work and other qualifications, as requested.

Two standard RACS management strategies are provided in this standard operating procedure, which are described in this following text. The Hand Removal strategy may be effective where small amounts of RACS (or Non-RACS) is likely to be found. The mechanical removal strategy may be effective where large amounts of RACS (or Non-RACS) is likely to be found. Again, the CCOD Project Manager, DDPHE, and the key parties should thoroughly evaluate site conditions before determining the appropriate RACS management strategy. Some projects may use both strategies at different times as the most effective way to manage RACS.

7.1 Hand Removal

During this action, the CABI will direct the contractor (or perform themselves) in the removal of these pieces of suspect or confirmed ACM (including RACS and Non-RACS) using the procedures listed below:

- The CABI will conduct a visual inspection of area and surrounding surface for the presence of suspect or confirmed RACS.
- Establish the RWA according to Section 7.2.1 (an RWA is not required if the material is determined to be a Non-RACS).
- Adequately wet the suspect or confirmed RACS and surrounding soil (12 inches) with amended water containing a wetting agent, such as a 50:50 mixture of polyoxyethylene ester and polyoxyethylene ether.
- Gather the RACS and remaining 12 inches of surrounding soil and place into double-bagged, 6-mil poly bags.

- The CABI will then complete a second visual inspection of the area and surrounding surface where minimal material was discovered to safeguard that no further RACS is in the scope area.
- If the CABI encounters further material after removal of the original discovery in which hand removal is not practical or effective, mechanical removal methods inside a RWA should be implemented.
- If RACS remains as part of the scope, it shall be managed according with Section 5.1.4 of this standard operating procedure.
- Dispose of waste in marked, 6-mil poly bags with attached generator labels in accordance with the CSWR §5.
- Hand-removed, bagged RACS waste may be stored in a leak-tight and secure container labeled for asbestos, and disposed in accordance with CSWR §5. Bagged RACS may not be stored for more than 10 days without a CDPHE-approved RACS storage plan.
- Asbestos worker and equipment decontamination shall be performed in accordance with Section 7.2.7.

Where there are minimal amounts of RACS/Non-RACS discovered as described above, the CABI may conduct the removal actions as stated in this standard operating procedure, and the utilization of an abatement contractor is not required (although an abatement contractor may provide trained asbestos workers to complete removal actions under the supervision of the CABI).

This method may also be applicable where other contaminants are present in soil (such as heavy metals or petroleum hydrocarbons), which are being managed in accordance with a MMP. During mechanical removal actions of special solid waste, the CABI must carefully (and safely) observe soil during the excavation process, prior to the material being loaded into trucks, to ensure that RACS is not overlooked. It may be necessary for the contractor to remove soil, carefully spread on the ground where it may be adequately visually inspected by the CABI (wetting as needed so there is no visible dust), and then re-excavate the material and place in dump trucks for landfill disposal. In no event may excavated soil that contains non-soil debris of any kind (Suspect or Non-Suspect) (e.g., non-ACM bricks, concrete, ceramic) be reused at an off-site location, whether if the property is owned by CCOD or not. These soils must be disposed at the Denver-Arapahoe Disposal Site (3500 South Gun Club Road, Aurora, Colorado 80018) as a special solid waste according with the MMP and CCOD's soil reuse policy (Section 3.6).

7.2 Mechanical Removal

Mechanical removal of RACS is often the safest and most cost-effective method of RACS management, particularly where large quantities of RACS/ACM is present, or is expected to be present.

7.2.1 Establishing a RWA after Confirmed Discovery of RACS

The contractor, under the direction of the CABI, will be responsible for establishing any RWA(s) for discovered RACS the CABI identifies, which will be removed, as follows:

- Establish a visible perimeter around the discovered material, which is identifiable to all persons on site, to prevent cross contamination. Demarcate area suspected of containing RACS with barrier tape, or other means, and provide access control.
- Post-labeling and signage to demarcate RWA(s). The RWA shall be demarcated with a visual means that defines the full extent of the RWA. Labeling and signage shall indicate the potential presence of asbestos, and that the area is off limits to unauthorized personnel.

7.2.2 Engineering Controls

7.2.2.1 Initial Minimum Controls

Minimum engineering controls will be implemented when excavations occur within the footprint of the RWA. The minimum engineering control include, but are not limited to, the following:

- A CABI must observe each area where soil disturbing or loading activities are taking place; therefore, if multiple excavations are occurring simultaneously, a CABI must be available to visually inspect each excavation location (i.e., utilize multiple CABIs).
- The CABI(s) will be on site at all times that RACS is being removed to ensure that no visible emissions are generated at any time during soil-disturbing activities. Additionally, the CABI will verify that the soil moisture is sufficient during removal to suppress dust, and to ensure that the material is adequately wet. If visible emissions are observed, then work practices will be modified.
- Stockpiled soils will be stabilized using the application of water or magnesium chloride, and/or by covering with overlapped poly sheeting or appropriate cover/stabilization.

7.2.2.2 Wind Break Barriers

As needed, wind break barriers should be constructed prior to commencement of removal activities, and constructed of materials appropriate to site conditions. Ultimately, wind break barriers will be the responsibility of the contractor. It is recommended that the wind break barriers be relatively portable and adequate to minimize soil dispersal from the work area. The wind break barriers will be placed to completely encompass the work area and loading area, as this will assist to prevent uncontrolled access to the work area by unauthorized personnel during and after work shifts.

7.2.3 RACS Disposal Procedures

7.2.3.1 Mechanical Removal/Disturbance of RACS from a Regulated Work Area

- Removal and disturbance of RACS will be conducted utilizing a direct-load system. RACS and its associated required removal quantities will be removed adequately wet and transported directly to DADS. Trucks will be prepared prior to loading by installing at least one leak tight 6-mil layer of poly as a liner (for non-friable RACS), or at least two layers of leak tight 6-mil poly (for friable RACS). The liner(s) will be installed such that under normal conditions, it (they) will not rupture during loading, transportation, and disposal. The poly liners will be sealed at the opened ends for transport with mechanical fasteners (i.e., tie wire, zip-ties, etc.).
- The project will have the option for all loads, based on continuous visual inspection and documentation by a CABI, to be determined to contain less than one percent (by volume of the load or container) of friable RACS, non-friable RACS or assumed ACM debris. In these cases, the loads shall be packaged and disposed of with one leak tight 6-mil layer of poly as a liner. If debris is assumed to be ACM, continuous CABI visual inspection is still required to determine if the amount of RACS remains below 1% of the disposal load.
- An area to load the trucks with RACS will be prepared as close to the RWA as possible, allowing safe access in and out of the site. A layer of 10-mil poly will be placed on the ground as a loading pad to capture potentially spilled RACS and immediately cleaned or replaced if any spillage or damage to the liner occurs.
- Standard erosion control BMPs must be established by the contractor to prevent stormwater run-on/off for the duration of the loading and transportation activities.
- Spill prevention measures, as outlined in CSWR §5.5.7(G), will be incorporated during loading of the RACS to prevent cross-contamination of adjacent areas. Specific measures include;
    - Protect surfaces of loading, transport or container equipment not meant to be in direct contact with RACS materials. Should these surfaces come into contact with RACS, they shall be decontaminated per section 7.2 of this standard operating procedure;
    - Do not overfill the excavator or loader bucket and return the bucket to a closed position prior to moving from the loading point;
    - Replace protective coverings when worn or damaged in order to prevent breaches;
    - Control runoff in order to prevent cross contamination outside of the RWA from water containing asbestos.
- Spilled RACS shall be treated as an RWA and cleaned up immediately in accordance with CSWR § 5.5.7 (J). It will not be allowed to dry out or accumulate on any surface. The

Department's Hazardous Materials and Waste Management Division shall be notified, through the spill reporting hotline, in the event that spills of RACS cannot be cleaned up within 24 hours of spill identification.

- Where there are breaches in ground coverings that have the potential to allow water contaminated with asbestos to impact the material below the covering or surfaces that are contacted by asbestos-contaminated water, a minimum of three (3) inches of soil, or other matrix material, shall be removed.
- If ground coverings are placed on top of a durable surface such as concrete or asphalt, the surface shall be decontaminated using wet methods, followed by CABI inspection that all soil and debris has been removed from the surface.
- Rinsate, runoff, or any other water that has come into contact with RACS shall be considered to be asbestos contaminated water and shall be collected. However it cannot be for discharge to a sanitary sewer or other Department-approved disposal facility. It may be re-applied to RACS that will be stabilized and managed under this SOP.
- Surfaces that are contacted by asbestos contaminated water can be permanently stabilized as per Section 5.1.4 of this standard operating procedure.

- Trucks carrying friable RACS (friable material over 1% by volume of the disposal load) must be labeled in accordance with the requirements of CSWR §5.5 using one of the following legends in type at least five inches tall:

CAUTION
CONTAINS ASBESTOS
AVOID OPENING OR BREAKING CONTAINER
BREATHING ASBESTOS IS HAZARDOUS TO YOUR HEALTH

DANGER
CONTAINS ASBESTOS
AVOID CREATING DUST
CANCER AND LUNG DISEASE HAZARD

- Non-friable RACS will be labeled "Asbestos, Danger" along with the name of the generator during transport.
- The contractor will be responsible for Department of Transportation protocols and labeling for transportation of RACS.

- It is likely that an excavator or front-end loader will be utilized for RACS removal, disturbance, management, and loading. During all soil-disturbing activities involving RACS, adequate wetting of soils will be performed. At least one water hose operator is required at each excavation, and other means may be employed to ensure that RACS is adequately wet (e.g., misting bars, additional hose operators).
- The equipment operator(s) will load the RACS directly into the pre-lined truck; the truck drivers will not be allowed to exit the trucks during loading operations and will be required to keep their windows closed and air handling systems off while their trucks are being loaded.
- The excavation bucket will not be filled greater than 2/3 its capacity to avoid overfilling and spilling.
- The CABI will continuously observe excavation and loading operations to verify that adequate wetting has taken place and that no visible emissions occur, and that compliance to this standard operating procedure is adhered to.
- During mechanical removal, if the CABI observes solid waste material (e.g., Non-Suspect material as described in Section 4.1), with no visible evidence of suspect ACM, and there is sufficient quantity, the CABI and contractor may elect to segregate this material for disposal as non-ACM.

7.2.3.2 RACS Removal Quantities

The extent of removal quantities differs depending on where the RACS disturbance is taking place as follows:

- When RACS is being removed from the **surface** – Wet and remove all RACS and its associated six-inches in all directions, plus a minimum of six inches of soil or other matrix material, in all directions from the last occurrence of visible ACM with CABI confirmation that the visible extent of RACS has been removed (i.e., removal of visible ACM plus a minimum 12-inches of soil in all directions).
- When RACS is being removed from the **subsurface** – Wet and remove all RACS and its associated six-inches plus a minimum of three linear feet of soil or other matrix material, in the direction of planned excavation with CABI confirmation that the visible extent of RACS has been removed.

7.2.3.3 Off-Site Disposal of RACS

It will be the responsibility of the contractor to direct the schedule of transportation of RACS to DADS. When loaded, each truck will be assigned a waste manifest to serve as the shipping document for that load. Documentation stating that the soil originating from the project shall not be used as a daily cover

or sold as clean fill will accompany each load of RACS removed from the project. DDPHE will coordinate the waste profile and obtain waste manifests if requested.

RACS will be transported to DADS. Disposal of RACS will be conducted while adhering to CSWR §5. The landfill processes will be followed, specifically regarding notification, profiling, and on-site disposal.

Disposal of Non-RACS will require notification to the landfill that the material to be disposed contains Non-RACS, and based on the DADS requirements, the material will be handled accordingly (e.g., unlined trucks, single-lined trucks). Special precautions shall be undertaken during the management of non-RACS to prevent the material from being turned into RACS (i.e. being rendered friable).

7.2.4 Wind Speed Monitoring

Periodic wind speed measurements will be taken during RACS disturbance within each RWA by an AMS or CABI at least once per every half hour. This frequency will be increased at the AMS's or CABI's discretion when it has been determined that wind conditions may be approaching threshold limits, and during wind gusts. It will be the responsibility of the AMS or CABI's to take and record all wind speed measurements onto the daily logs. All wind speed measurements will be taken within the work area in a location deemed representative of the area. The following are conditions where work will be shut down and started:

Shut down Conditions – RACS disturbance operations should immediately and temporarily cease when one or more of the following conditions have been met:

- Any wind gust reaches or exceeds 20 miles per hour (mph) as determined by hand-held instruments
- Sustained wind speeds reach or exceed 12 mph averaged over a 10-minute period
- Winds produce visible emissions or create movement of dust or debris in or near the work area or loading area
- Winds impact any engineering controls and prevents them from functioning as designed
- During wind-related project shutdowns, other work not related to RACS disturbance may continue

Startup Conditions – RACS disturbance operations may resume after all the following conditions have been met:

- All wind gust readings drop below 20 mph for a period of 20 minutes as determined by hand-held instruments
- Sustained wind speeds are below 12 mph averaged over a 20-minute period

- Winds no longer produce visible emissions or create movement of dust or debris in or near the RACS disturbance area
- Winds are not impacting the ability of engineering controls to work as designed

7.2.5 Air Monitoring

CDPHE will require minimum air monitoring when suspect or confirmed ACM/RACS is being disturbed within a RWA, after the second consecutive day of RACS management. An appropriately trained and certified AMS must perform the air monitoring activities at the project. The CABI will characterize debris and air monitoring requirements will be made by the AMS based on the CABIs identification of the debris and applicable regulations. The CABI and AMS can be the same person if she/he meets the CABI and AMS requirements in Section 3.3. Ideally, the CABI and AMS will be the same person.

Air monitoring samples will be collected by the AMS using the procedures outlined below. All air samples will be collected and analyzed in accordance with CSWR §5.5 – Appendix 5A.

7.2.5.1 Air Monitoring Matrix Tables

Personnel Monitoring and RWA Perimeter Sampling shall be performed in accordance with the following air-monitoring matrix tables:

Table 3 Removal/Disturbance (by hand or hand-held tools) of Non-Friable RACS

Monitoring Type	Sample Frequency	Duration	Analysis
RWA Perimeter Monitoring	None	Not Applicable	Not Applicable

Table 4 Removal/Disturbance (by hand or hand-held tools) of Friable RACS

Monitoring Type	Sample Frequency	Duration	Analysis
RWA Perimeter Monitoring	Four samples at the perimeter of the RWA, at the points of the compass.	Ongoing after the 2nd day of RACS disturbance	PCM and Transmission Electron Microscopy (TEM) sampling around RWA. Any sample with PCM results exceeding 0.01 fibers per cubic centimeter (f/cc) must be analyzed by TEM.

Table 5 Removal/Disturbance by Mechanical Means (Heavy Equipment) of Non-Friable RACS

Monitoring Type	Sample Frequency	Duration	Analysis
RWA Perimeter Monitoring	Four samples at the perimeter of the RWA, at the points of the compass.	Ongoing after the 2nd day of RACS disturbance	PCM and TEM sampling around RWA. Any sample with PCM results exceeding 0.01 fibers/cc must be analyzed by TEM.

Table 6 Removal/Disturbance by Mechanical Means (Heavy Equipment) of Friable RACS

Monitoring Type	Sample Frequency	Duration	Analysis
Area of Disturbance Perimeter Monitoring	Four samples at the perimeter of the RWA at the points of the compass, and two downwind floater samples.	Ongoing after the 2nd day of RACS disturbance	PCM and TEM sampling around RWA. Any sample with PCM results exceeding 0.01 fibers/cc must be analyzed by TEM.

7.2.5.2 Personnel Air Monitoring

Personnel monitoring will be the responsibility of the contractor, per OSHA requirements, and is not directed by this standard operating procedure.

7.2.5.3 Required Preliminary and Area Air Sampling Protocol

- **During the first five days of RACS disturbance/removal** – All air samples collected are required to be analyzed by PCM methodology. Additionally, a minimum of 25% of the samples collected from each RWA shall be submitted for TEM analysis. The sample(s) selected for TEM analysis shall have the highest PCM result(s) based on fiber concentration. If all PCM results are Below Detectable Limit (BDL) for fiber concentration, then the sample(s) selected for TEM analysis shall be determined by highest fiber count. If all samples have no fiber counts, then no TEM analysis is required.
- **After five days of RACS removal/disturbance with no asbestos detections by TEM analysis** – the frequency of analysis by TEM, on the highest 25% of PCM results(s), may be reduced to once every five days of RACS removal/disturbance, or portions thereof, using the same selection criteria as above. During the period of reduced frequency of TEM analysis, the first occurrence of high winds, exceeding wind shutdown criteria (Section 7.2.4), or visible

emissions, shall result in that day's samples (25%) being submitted for TEM analysis. In the absence of high-wind events or visible emissions the selected day for TEM analysis may be random, as determined by the AMS.

- If at any time, a sample analyzed by PCM returns results greater than 0.01f/cc, that sample shall then be analyzed by TEM as required by CDPHE.
- If there are any asbestos detections during the random once-every-five-days-analysis by TEM, then TEM analysis shall be conducted for three consecutive days of RACS removal/disturbance, or portions thereof. If there are no additional asbestos detections during the three consecutive days of RACS removal/disturbance with samples submitted for TEM analysis, then the frequency of TEM analysis may return to random, once-every-five-days of RACS removal/disturbance.

7.2.5.4 Area Air Sampling

- Air samples will be collected continuously during all mechanical removal of RACS.
- Area monitoring shall consist of a minimum of four samples collected on the perimeter of the RWA, at the four-compass points, and at appropriate intervals to provide representative information regarding potential releases of asbestos fibers to the Adjacent Receptor Zone(s).
- Two additional downwind floating samples will be required for mechanical removal/disturbance of friable RACS. The samples shall be moved based on prevailing wind direction and adjacent receptors.
- Additional samples shall be collected for large perimeter RWAs (greater than one (1) acre). RWAs greater than one (1) acre shall require additional perimeter monitoring points be added at a rate of one (1) sample for every 200 linear feet (or approximately each additional ¼ acre).
- Air monitoring is not required where RACS management activities will occur in areas where there is no Adjacent Receptor Zone present according to the definition of an adjacent receptor zone where access to the public can be controlled (i.e., an area of at least 150 feet surrounding the RWA can be controlled allowing no public access).

7.2.5.5 Sampling Media

Air samples will be collected by drawing air through a 25-millimeter mixed cellulose ester filter, 0.8-micron pore size, with an open-faced, long cowl using low-flow personnel sampling pumps. The flow rate and the volume of the air passed through the filter will be determined based on the National Institute of Occupational Safety and Health (NIOSH) 7400 (NIOSH, 1987) analytical method. Each pump will be calibrated before and after the collection of each sample using a primary standard.

7.2.5.6 Sample Analysis

Air samples submitted for Phase Contrast Microscopy (PCM) shall be analyzed according to NIOSH Method 7400 by a laboratory showing successful participation in the American Industrial Hygiene Association (AIHA) Proficiency Analytical Testing (PAT) Program or individual(s) certified through the AIHA Asbestos Analysts Registry (AAR) Program. Analysis of TEM air samples will be submitted to a National Institute of Standards and Technology (NIST) accredited laboratory using TEM in accordance with CSWR §5.5 Appendix 5A (Appendix D).

7.2.5.7 Response to Laboratory Results

If an air sample analyzed by PCM indicates fiber concentrations over 0.01f/cc, that sample is then required to be analyzed by TEM. If an air sample has concentrations of airborne asbestos fibers after TEM analysis of personnel and/or work RWA samples, then the CDPHE will be notified immediately. The work practices and engineering controls, through consultation with CDPHE, will then be modified to reduce emissions. In the event that this should occur, the following actions shall take place:

- Excavation will immediately halt
- The source(s) of fiber release will be identified
- RACS management operations and engineering controls will be reassessed to safeguard that additional fiber releases do not occur
- If asbestos fibers are detected in air samples:
    - All soil-disturbing activities will immediately cease
    - The source of fiber release will be identified
    - An Emission Control Plan in accordance with Section 5.5.7 of the CSWR §5.5 will be derived and submitted to CCOD and the CDPHE for review
    - Soil disturbance shall not continue until the CDPHE provides verbal and/or written authorization to proceed.

7.2.6 RACS Stockpiling

7.2.6.1 Stockpiling of RACS

If RACS, which must be removed from the project, is in a location with limited or no access for direct loading into trucks, the material may be stockpiled on site if the conditions below are met in accordance with CSWR §5.5:

- The accumulation of RACS cannot exist for more than 10 calendar days without the approval of a RACS Storage Plan by CDPHE.

- Stockpiled RACS shall be placed on a minimum of 6-mil poly or a minimum of three-inches of soil, or other matrix material located under the stockpile which must be removed following removal of all stockpiled material.
- Rinsate/runoff shall be collected, filtered to five-microns, and discharged to a sanitary sewer (contractor must have appropriate authorizations) or re-applied to RACS that will be stabilized and managed under this standard operating procedure.
- The RACS must be adequately wet during stockpiling.
- The stockpile shall be stabilized by polyethylene sheeting, geofabric, or a chemical stabilizer demonstrated to be effective in the stabilization of RACS (e.g., magnesium chloride).
- The condition of the stockpile and cover sheeting/geofabric/stabilizer must be inspected daily and no later than 12 hours following storm events.
- All damage to the cover sheeting/geofabric/stabilizer must be repaired or replaced immediately upon discovery.

7.2.6.2 Transporting RACS to Stockpile

The following directives and RACS handling must take place during on-site transport of RACS to a stockpile location:

- Driving speeds shall not exceed 12 mph while machine is moving RACS.
- Transportation equipment tires shall not contact RACS. If tires do contact RACS, the RACS must be adequately wetted to prevent dust/emissions and all equipment surfaces that have come into contact with RACS shall be decontaminated (Section 7.2.7).
- If the transport equipment tires come in contact with RACS:
    - The haul road shall be managed as RACS and maintained to prevent dust or emissions generation and if any RACS is visibly observed it is to be removed immediately, along with the required six inches of surrounding soil and handled appropriately.
    - Following completion of excavation and grading activities, the material used in construction of the haul road as well as three inches of underlying soil will be removed and managed in the same manner as the RACS.
    - Water and runoff from the haul road shall be collected and filtered to less than five microns (or applicable local requirements) and discharged to a sanitary sewer (contractor must have appropriate authorizations) or re-applied to RACS that will be stabilized and managed under this standard operating procedure.

7.2.7 Decontamination Procedures

7.2.7.1 Heavy Equipment or Machinery Decontamination

Heavy equipment will be decontaminated prior to leaving a RWA in such a manner as to ensure that residual soil and contaminants are removed and other hazards are not present. Heavy equipment decontamination will include the following steps:

- Decontamination will occur within a waste container when possible, and if not will be staged on 6- or 10-mil poly to prevent cross contamination or spills. This will include mechanical removal by asbestos workers using shovels or other hand-held tools while wearing appropriate PPE.
- Next, the equipment will be thoroughly cleaned with amended water and rags.
- All used rags and disposable PPE will be disposed of as asbestos waste and transported to the landfill.
- It will be the responsibility of the CABI to make final visual inspections and a final determination regarding the decontamination of equipment for release to other portions of the project, or off-site.

7.2.7.2 Asbestos Worker Decontamination During RACS Disturbance in a RWA

A fully functioning decontamination unit or trailer will be utilized at the project whenever RACS disturbance within a RWA takes place. The decontamination unit will be located within 100 feet of the project, and as near the removal area as practical. The decontamination unit will consist of three chambers, should have fully operational hot and cold running water adjustable at the tap, and a functioning water filtration unit that will filter the waste water to five microns or less. Reuse of waste water from personnel decontamination is prohibited. For disposal, waste water may not be discharged to the sanitary sewer within the City and County of Denver. However, it may be added to RACS, generated by the project, as part of RACS disposal procedures if it does not interfere with the requirements of section 7.2.3 (RACS Disposal Procedures) of this SOP, and does not cause the load to fail a paint filter test. Disposal of decontamination water from equipment must also follow the same disposal protocols. In no event may decontamination water be discharged to any sanitary sewer, storm sewer, ditch, gutter, or stream.

To prevent cross-contamination, asbestos workers will wear clean outer protective suits as they exit from the work area(s) to the decontamination area. The asbestos workers will either double suit and remove the exterior suit, or don a second clean suit over the single suit, within the work area prior to moving out of the RWA to get to the decontamination unit. The decontamination unit should be utilized by the asbestos workers each time they exit the work area(s).

7.2.7.3 Decontamination and Personnel Protection During Removal of RACS/ACM

Asbestos workers and equipment will be decontaminated on site; dirt and debris should not leave the immediate work area. The following procedures can be modified by the CABI based on the potential level of exposure:

- Decontamination of workers can consist of removal of disposable Tyvek® suites, gloves, and boot covers. These PPE will be bagged, labeled, and disposed as asbestos waste.
- Decontaminate non-disposable personal items by removing visible soil and dust with damp wipes or rags, or by use of a high efficiency particulate air (HEPA) filter equipped vacuum. Place wipes and rags in a plastic bag and dispose along with RACS materials. If additional clothing is available, clothes should be changed and potentially contaminated clothing should be bagged separately from wipes and rags.
- Decontaminate hand equipment and tools by removing gross soils and dust, then washing the equipment. Materials used for decontamination should be bagged and disposed along with RACS materials. Equipment decontamination rinsate water should be collected and filtered to five microns prior to disposal, or reused for wetting of asbestos contaminated areas that will be removed.

Based on analytical results of suspect materials, if asbestos is present, decontamination materials should be bagged and disposed of as asbestos waste at the Denver-Arapahoe Disposal Site or with RACS in accordance with this plan. If analytical results indicate that no asbestos is present, bags (non-asbestos waste bags) can be disposed as non-asbestos solid waste.

7.2.8 Work Area Clearance

It will be the responsibility of the CABI to provide final visual clearance of the work area following completion of RACS disturbance/removal. The CABI will document locations, and other pertinent information, onto the daily logs for work area clearance.

8. Close-Out Report

The CABI will be responsible for maintaining complete documentation of the project in accordance to C.S.W.R 5.5.7 (L). After RACS disturbance/removal actions are completed, a project close-out report will be prepared for CCOD's files. The project close-out report will include at a minimum:

- Property description and description of area(s) with RACS
- Description of soil-disturbing activities
- Description of field operations or submittal of daily logs (Appendix B)
- Air monitoring logs
- Description/results of asbestos sampling events, including sample locations
- Analytical results
- Disposal summaries and manifests
- Details of excavation profiles
- Description of capped material left in place and site plan showing the capped area(s)
- Photographic logs
- Personnel certifications

Copies of the project close-out report will be submitted to the CCOD Project Manager. Project close-out reports for RACS management projects are not required to be submitted to CDPHE.

9. References

CDPHE, 2008. "Regulation No. 8, Part B – Asbestos", Colorado Department of Public Health and Environment, Air Quality Control Commission, Denver, Colorado, January 2008.

CDPHE, 2014. "Deletion and Replacement of Existing Section 5.5 Regulations (Management of Asbestos-Contaminated Soil) with New Section 5.5 Regulations (Management of Regulated Asbestos Contaminated Soil (RACS)); the Addition of Appendix 5A (Sample Collection Protocols and Analytical Methodologies) and the Associated Additions and Revision to Section 1.2 Definitions." Colorado Department of Public Health and Environment, dated August 19, 2014.

NIOSH, 1987. National Institute for Occupational Safety and Health (NIOSH) Method 7400 Entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, second supplement, August 1987.

OSHA, 1987. Occupational Safety and Health Administration (OSHA) Regulation "Asbestos", 29 C.F.R. Part 1910.1001, Appendix B (OSHA 1987)

Appendices

Appendix A
CDPHE Approval Letter

COLORADO
Hazardous Materials
& Waste Management Division
Department of Public Health & Environment

Dedicated to protecting and improving the health and environment of the people of Colorado

May 2, 2019

Mr. Steve Gonzales
City and County of Denver
Department of Public Health and Environment
101 W. Colfax, #800
Denver, CO 80202

RE: **Approval:** *Regulated Asbestos Contaminated Soil Standard Operating Procedure for City and County of Denver* - dated May 2, 2019
SW/DNV/GEN 3.10

Dear Mr. Gonzales:

The Colorado Department of Public Health and Environment ("CDPHE"), Hazardous Materials and Waste Management Division ("Division") has reviewed the following standard operating procedure (SOP) regarding Regulated Asbestos Contaminated Soil (RACS) management activities in Denver, CO:

- *Regulated Asbestos Contaminated Soil Standard Operating Procedure for City and County of Denver* (the SOP)

The SOP was initially received in our office electronically on May 9, 2018. The Division provided comments on the initial version of the plan that were dated June 13, 2018. A revised version of the plan was received electronically on September 5, 2018. The Division provided additional comments in a letter dated November 2, 2018. Another revision to the SOP was dated January 23, 2019. Additional discussion between the Division and the Denver Department of Public Health and Environment resulted in a final version of the SOP that was provided to the Division on May 2, 2019. The SOP was prepared and submitted by The Denver Department of Public Health and Environment.

The Division has completed its review and is pleased to hereby approve this SOP for RACS Management. Please keep in mind that all soil disturbing activities involving RACS must be performed in accordance with this approved SOP and the Colorado Solid Waste Regulations (6 CCR 1007-2, Part1).

In closing, the Division is authorized to bill for is review of technical submittals at $125 per hour, pursuant to Section 1.7 of the Solid Waste Regulations, 6 CCR 1007-2. An invoice for the Division's review of the above referenced document will be sent out under separate cover.

The Division contact person for this project is Brian Long, and may be contacted at (303) 691-4033 or briant.long@state.co.us.

Sincerely,

Digitally signed by Brian Long
Date: 2019.05.02 16:37:42 -06'00'

Brian T. Long
Environmental Protection Specialist
Solid Waste Compliance Assurance Unit
Solid Waste and Materials Management Program

ec: Ed Smith, CDPHE HMWMD

Appendix B
CABI Work Day Documentation Form

City and County of Denver

Certified Asbestos Building Inspector Work Day Documentation

Project Name_____

DDPHE V1.0

Inspector Name:		**Date:**	
Inspector Certification Number: **Inspector's Company/Affiliation:**		**Weather:**	
Location Description:			
Description of Site Activities :			
Equipment Used (Model Number):			

CABI Documentation

Identify environmental hazards discussed at the safety meeting:

- ☐ Delineation of Work Area
- ☐ Work Zones
- ☐ Utility Identification
- ☐ Haul Routes / Access
- ☐ Equipment Mobilization
- ☐ Emissions Controls
- ☐ Fencing and Wind Barriers
- ☐ Other:_____

Description of Encountered Debris Materials and Practices

1A	**Types of Debris Identified (List all materials, clarify depths of piles):**
1B	**Description of Suspect Debris Material (RACS/ Non-RACS):**
1C	**Description of Hand Removals (Assumed RACS or Analyzed To Be RACS):**
1D	**Friability of Suspect Debris Materials:**
1E	**Observation of Non-Earthen Material or the Appearance of Fill:**
1F	**Observation of Any Other Impacted Soils (Non-Asbestos Impacts):**

Bulk Sample Log

Sample ID#	Time Sampled	Depth	Sample Location/Description	Asbestos Content From Analytical

RACS Management Detail

Decontamination

No.	Items	YES	NO	
2A	Have all equipment surfaces in contact with RACS been decontaminated?	○	○	
	Details:			
2B	Have workers conducted personal and equipment decontamination in accordance with applicable procedures?	○	○	
	Details:			

Engineering and Administrative Controls

No.	Items	YES	NO	
3	Onsite Staging, Stockpiling, & Storage of RACS	○	○	
	Annual Awareness Training for Regulated Work Area Personnel	○	○	
	Annual Awareness Training for Non-Regulated Work Area Personnel	○	○	
	Details: (provide detailed description of any deficiencies)			

Spill Response

No.	Items	YES	NO	
4		○	○	
	Details (provide information on corrective actions):			

Air Monitoring Information As Applicable

General Conditions

No.	Items	YES	NO	
5A	Were work conditions maintained below stoppage requirements?	○	○	

Daily Wind Speed — **Sustained High:** _____ **Gust Max:** _____

Details (Provide Prevailing Wind Direction and 30-Minute Readings):

Time	Wind Speed	Direction	Time	Wind Speed	Direction
7:00			12:00		
7:30			12:30		
8:00			13:00		
8:30			13:30		
9:00			14:00		
9:30			14:30		
10:00			15:00		
10:30			15:30		
11:00			16:00		
11:30			16:30		

Comments:

Details of Wind Shut Down Event (If Applicable):

5B	Visible emissions observed?	○	○
	If visible emissions were observed, was worked stopped?	○	○
	Details (provide information on corrective actions):		

Perimeter Monitoring

6A	Adequate perimeter sampling points based on test area?	○	○	
	No disturbance to sampling equipment or power source?	○	○	
	Were samples compromised in any way?	○	○	
	Details:			
6B	Has the pump been calibrated?	○	○	
	Details (Pump Calibration Method):			
6C	Is there an adjacent public receptor zone within 150 ft. of a Regulated Work Area?	○	○	
	Details (Location):			

Air Sample Log

Sample ID#	Start Time	Stop Time	Total Minutes:	Flow Rate Start:	Flow Rate Stop:	Sample Location	Volume	f/cc

Contractor Monitoring

No.	Items	YES	NO	
7	Is contractor working in the regulated work area conducting personal monitoring?	○	○	
	Details:			

Work Practices and Completion

No.	Items	YES	NO	
8A	Are work practices conducted in accordance with the project MMP and State regulations?	○	○	
	Have excavation and loading activities been conducted in accordance with applicable procedures?	○	○	
	Details:			
8B	Have loading and transportation requirements been met?	○	○	
	Details:			
8C	Has visible material and associated soils been removed?	○	○	
	Details:			
8D	Have appropriate samples been collected to confirm ACS has been removed?	○	○	
	Details:			

Soils Disposition

9A	Where did the soil originate (depth, specific area)?
9B	Temporary or final disposition of soil (where on-site or disposed)?
9C	Method of material movement (What type of truck and loading)?

How many cubic yards of soil excavated during shift? (0 - 10000 yds.)	

Comments:

Provide at least 4 Photos From Daily Operations Where RACS Management Is Being Done

During RACS Management Operations, Include a Map of RACS Management Location(s) with this Documentation

ASSOCIATED PHOTOS

Picture 1

Picture 2

Picture 3

Picture 4

CABI Field Inspector Name

Date

Appendix C
Notification of Planned Soil Disturbing Activity

COLORADO
Department of Public Health & Environment

Dedicated to protecting and improving the health and environment of the people of Colorado

NOTIFICATION OF REGULATED ASBESTOS CONTAMINATED SOIL (RACS) DISTURBANCE

A map, figure, or drawing, to a recognizable engineering scale, depicting the project area(s) must be submitted with this form.

The form, plan (if applicable), and depiction of the project area, can be emailed to: briant.long@state.co.us; or, mailed to: Colorado Department of Public Health and Environment, HMWMD-B2 Attn: Brian Long, Solid Waste Compliance Assurance Unit, see address below.

Date and time reported:		
☐ **Planned management** **Start date:** **Estimated duration:**	☐ **Unexpected discovery (submit within 24 hours of discovery)** **Discovery date and time:** **Estimated duration:**	
Description of planned soil-disturbing activities:	**Description of activities resulting in RACS discovery/disturbance:**	
Description of any access and/or emission control measures already implemented at the site:	**Description of type and quantity of RACS discovered/disturbance:**	
☐ **This is an EMERGENCY management event (submit this form within 24 hours of RACS discovery, and comply with the Minimum Standards to the extent possible during initial management, and fully comply within 48 hours)** **Detail the nature of the emergency (e.g., repair to an active utility line):**		
Check the box to indicate which management approach will be utilized on this project:		
☐ **Project Specific RACS Mgmt. Plan** **Submit PSRMP for Division review and approval with this form at least 10 working days prior to commencing RACS disturbing activities.** **RACS disturbance shall not commence until the PSRMP is approved. However, the standard requirements from Section 5.5.7 of the Solid Waste Regulation may be used in the interim after the required notice.**	☐ **Standard Operating Procedures** **Has the Division approved SOPs for this project?** ☐ **Yes, include the name of the SOP here:** **Notification shall be submitted to the Division prior to commencing RACS disturbing activities.** ☐ **No, submit SOPs for Division review and approval with this form at least 30 calendar days prior to commencing RACS disturbing activities.**	☐ **Remediation Plan** **Submit remediation plan for Division review and approval at least 45 calendar days prior to commencing RACS disturbing activities. Remediation shall not commence prior to plan approval.**
☐ **Standard Requirements** **The standard requirements of RACS management are found in Section 5.5.7 of the Solid Waste Regulations. Notification shall be submitted to the Division prior to commencing RACS disturbing activities.**		☐ **Risk Based Approach** **Submit a site-specific risk assessment work plan for Division review and approval with this form prior to commencing RACS disturbing activities. RACS disturbance shall not commence until the plan is approved.**
Please indicate which program this project will take place under: ☐ **Solid Waste (general) /** ☐ **Voluntary Cleanup Program (VCUP) /** ☐ **Hazardous Waste Corrective Action (RCRA) /** ☐ **Federal Facilities or CERCLA /** ☐ **Don't Know**		
Contact person for entity performing soil-disturbing activity:		
Organization, company or agency:		
Email:	**Phone:**	
Name of property owner/operator:		
Owner/operator contact (if different):		
Email:	**Phone:**	**Ext:**
Location of property: (Street address or other location description)	**Street Address:**	
	County: / **City:** / **Zip:**	
General site description:		

Received by:_____ Date:_____

Appendix D
Sample Collection Protocols and Analytical Methodologies

CSWR §5.5 – APPENDIX 5A
SAMPLE COLLECTION PROTOCOLS AND ANALYTICAL METHODOLOGIES

1.0 Purpose

(A) The purpose of this appendix is to establish standard sample collection requirements and analytical methods and procedures for use in identifying and quantifying asbestos fibers in air, bulk material, and environmental media such as soil or ash.

2.0 Sample Collection Requirements

(A) The following sample collection requirements shall be followed when collecting samples for the purpose of determining the applicability of Section 5.5, and when collecting samples necessary to comply with the requirements of Section 5.5. Remediation plans submitted in accordance with Section 5.5.6 shall include a site specific sampling and analysis plan that incorporates the sample collection methodologies and analytical procedures in this Appendix, or proposes alternatives, and include site specific clearance criteria.

2.1 Bulk Samples

(A) Bulk samples shall be collected, in a manner sufficient to determine whether the material is asbestos-containing material (ACM) or not ACM, from each type of suspect ACM. Bulk samples shall be collected by a State of Colorado certified Asbestos Building Inspector (CABI). In the absence of bulk sample collection, any suspect ACMs must be assumed to be ACMs.

(B) Bulk samples shall be collected by homogenous type based on color, pattern, texture, thickness, associated materials, or by other identifying characteristics. Additionally, the quantity and location of a suspect material shall be used to determine the number of bulk samples required to characterize the asbestos content of each homogeneous suspect material. For the purpose of determining that a homogeneous suspect material does not contain asbestos, a minimum of three (3) bulk samples shall be collected from the homogeneous material unless there is insufficient material to constitute three (3) samples. If one of the collected samples of a homogeneous bulk material is determined to be ACM, then the homogeneous material shall be considered ACM.

2.2 Soil Samples

(A) Samples collected to determine asbestos content in soil shall be ten (10) point aliquot composite samples collected from a maximum area of 1,250 square feet (representing 0-6 inches beyond the exposed surface) or a maximum volume of forty (40) cubic yards. Individual aliquots shall be approximately 1/10 of the entire sample volume. At each aliquot location approximately one (1) tablespoon of soil shall be collected. The total volume of the ten (10) aliquots should equal roughly a half cup. The total collected sample volume should be greater than one quarter (¼) cup, but should not exceed one cup. Aliquot locations shall be randomly selected but shall be representative of the entire sample area or volume (to be inclusive of the interior of soil piles in addition to the surface). However, aliquots shall be co-located with any areas where friable ACM was formerly present. All samples collected to determine asbestos content shall be collected by a CABI.

(B) Sampling for clearance purposes of any exposed horizontal or vertical surface shall have the following additional requirements:

1) The aliquots of a clearance sample shall not be collected until after the RACS, and the required amount of associated material, has been removed.

2) A visual inspection shall be performed and passed (i.e., no visible ACM present) by a CABI prior to the collection of soil samples. Visual inspections shall include the following:

   a) The area to be cleared shall be designated before the visual inspection; and
   b) Former locations of friable materials shall be designated; and
   c) The surface being inspected shall be dry enough to allow identification of suspect ACM; and
   d) The visual inspection shall be conducted in adequate lighting; and
   e) The area to be cleared shall be free of visual impediments (e.g. snow cover, plastic sheeting, standing water, etc.); and
   f) At a minimum, the area to be cleared shall be inspected in at least two (2) perpendicular directions; and
   g) Single or multiple inspectors may be used to perform a visual inspection and clearance. However, a single inspector shall not

visually inspect more than a five (5) foot width with each pass [i.e. for a clearance area that is 25' x 50' a single inspector would be required to make at least five (5) passes in one direction (25' length) and at least ten (10) passes in the other direction (50' length)]; and

h) Detailed close examination of the area being cleared is required. The inspector(s) should use limited invasive inspection techniques, such as periodically sifting the surface being cleared and closely inspecting the disturbed area.

3) If sidewalls with six (6) inches or greater of vertical height are present, independent ten (10) point aliquot composite samples shall be collected from each of the sidewalls and the floor of the excavation.

2.3 Ash Samples

(A) Ash that contains, or is comingled with, suspect ACM and/or construction and demolition debris shall be considered to be RACS unless the ash is sampled, and analysis demonstrates that the ash is not RACS. Representative samples of each type of ash materials shall be sampled and analyzed in the same manner as soil (including area/volumetric limitations of sampling). Ash samples shall be collected by homogenous strata, location, content of other surrounding material, or other observations indicating heterogeneity of the ash present. All samples collected to determine asbestos content shall be collected by a CABI. In the absence of suspect ACM or construction and demolition debris, and in the absence of documented evidence of non-visible asbestos, ash material may be treated as non-RACS.

2.4 Cross Contamination Prevention

(A) All sample collection equipment shall be decontaminated in a manner sufficient to prevent cross contamination between individual samples or individual composite samples. Decontamination is not required between the collection of aliquots comprising a single composite sample.

2.5 Air Samples for Standard RACS Management

(A) Air samples shall be collected by drawing air through 0.8-micron (µm), 25-millimeter (mm), mixed cellulose ester (MCE) filters, using an open-faced cowl extension oriented face down at an angle of 45°. Sample flow rate shall be between 0.5-10 liters per minute depending on the anticipated duration of sampling and the specified detection sensitivity. The air sampling equipment

shall be run until the minimum volume required is collected for each sample. However, if the minimum air volume required by the method, and/or to reach the required analytical sensitivity, being utilized cannot be met, the State of Colorado trained and certified Air Monitoring Specialist (AMS) shall request that the laboratory prepare the sample using an indirect preparation method, for TEM presence/absence analysis. Air samples shall be collected at a height that is representative of the disturbance activity taking place. However, air samples shall be located at a height between three (3) feet above the ground surface but not to exceed twenty (20) feet above the ground surface. Air samples shall be collected by an AMS.

2.6 Air Samples for Risk-Based Air Threshold Monitoring

(A) Air samples shall be collected by an AMS. Air monitoring shall be conducted during each partial or full day of soil management activities using fixed and mobile monitors as follows:

1) A minimum of four (4) samples shall be collected for each regulated work area (RWA).
2) For the purpose of determining the number of samples necessary, each RWA shall be divided into four (4) equal quadrants. A minimum of one (1) sample shall be collected for each quadrant with an adjacent receptor zone.
3) If an RWA is greater than one (1) acre, one (1) additional sample for each quadrant with an adjacent receptor zone shall be collected and analyzed for each additional one quarter (¼) acre in RWA surface area.
4) Samples shall be located along the RWA perimeter, between the RWA and each adjacent receptor zone. Samples shall be placed between the RWA and any fixed adjacent receptor(s). In the absence of fixed adjacent receptors, sample placement shall be at the AMS's discretion.
5) The sample volume shall be the minimum necessary to meet analytical sensitivity.
6) Samples shall be collected by drawing air through 0.8-micron (µm), 0.25-millimeter (mm), mixed cellulose ester (MCE) filters, using an open-faced cowl extension oriented face down at an angle of 45°.

3.0 Analytical Requirements

(A) The following analytical methods shall be used to evaluate the presence of asbestos and/or to determine asbestos content when analyzing samples for the purpose of determining the applicability of Section 5.5, and when analyzing samples collected in accordance with Section 5.5:

3.1 Bulk Samples

(A) Samples of suspect ACM shall be analyzed by polarized light microscopy (PLM), according to United States Environmental Protection Agency (USEPA) Method EPA/600/R-93/116 or equivalent method, to determine if any asbestos fibers are present. If the asbestos content of a sample is estimated to be 1% asbestos or less, but greater than 0%, by a method other than point counting (such as visual estimation), the determination shall be repeated using the point counting technique with PLM. Alternatively, the material may be assumed to be ACM. Analysis shall be conducted by a National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory.

3.2 Soil Samples and Ash Samples

(A) Prior to preparation of a soil or ash sample, bulk materials shall be separated from the soil or ash sample for independent analysis. Any bulk materials identified in a soil or ash sample that contain any amount of asbestos shall be reported as independent layers of the whole sample. The samples shall be adequately prepared (crushed and dried) to facilitate stereomicroscopic analysis by the laboratory. The goal of the preparation process should be to produce dried conglomerates of approximately one eighth inch (1/8") to one quarter inch (¼") size. Rock and/or stone material does not need to be crushed (this process is not intended to be homogenization). Soil and ash samples shall be analyzed by PLM according to USEPA Method EPA/600/R-93/116 to determine if any asbestos fibers are present. Analysis shall be conducted by a National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory. During the stereomicroscopic analysis (10X – 50X) of the soil/ash sample the analyst shall sift through the sample at a rate of approximately one (1) tablespoon per minute. At the end of the stereomicroscopic analysis the sample shall be agitated or shaken as a final check for asbestos prior to the preparation of PLM grab mounts. At no time during the stereomicroscopic analysis shall a sub sample be collected. The entire sample shall be analyzed and the results reported. If no asbestos was identified by PLM after the initial stereomicroscopic examination, then three (3) random grab mount preparations shall be analyzed by PLM to determine if the sample is none detected for asbestos content. If any asbestos is found by the laboratory it shall be reported even in the absence of a second detection (i.e. there does not need to be a second detection to qualify a trace level of asbestos in the sample). Quantification of asbestos content shall be based on the entire sample volume, and be reported as such.

3.3 Air Samples for Standard RACS Management

(A) Air samples submitted for Phase Contrast Microscopy (PCM) shall be analyzed according to NIOSH Method 7400 by a laboratory showing successful participation in the American Industrial Hygiene Association (AIHA) Proficiency Analytical Testing (PAT) Program or individual(s) certified through the AIHA Asbestos Analysts Registry (AAR) Program.

(B) Air samples submitted for Transmission Electron Microscopy (TEM), for which quantification of asbestos is desired, shall be prepared and analyzed according to the standard Asbestos Hazard Emergency Response Act (AHERA) method (AHERA; 40 CFR Part 763, Subpart E, Appendix A). All TEM analysis shall be performed by a NVLAP accredited laboratory. If a presence/absence analysis is desired, the analysis shall be performed using the AHERA method modified in the following manner:

1) A minimum of two (2) preparations shall be prepared and utilized for each sample.
2) Analysis shall be conducted on a minimum of four (4) grid openings or until three (3) or more structures are identified, whichever comes first.
3) Any structure (adhering to the AHERA counting rules) identified during analysis shall be reported.
    a) Identification of less than three (3) structures shall be reported as present.
    b) Identification of three (3) or greater structures shall be reported as detected.

(C) Any air sample analysis that results in a “cannot be read (CBR)” determination from the analyst, or a “not analyzed (NA) or rejected” due to loose debris or uneven loading, shall be evaluated by the AMS to determine if a cause of the CBR or NA can be ascertained. If it is determined that the CBR is a result of overloading from airborne emissions, then the AMS shall request that the laboratory prepare the sample, using an indirect preparation method, for TEM presence/absence analysis.

3.4 Risk-Based Air Threshold Samples

(A) Air samples collected for TEM analysis shall be submitted to a NVLAP accredited laboratory. Samples shall be analyzed by TEM according to ISO Method 10312 with the following modifications for PCM equivalent (PCMe) structures:

1) An aspect ratio of 3:1 shall be used when counting structures greater than 5 µm in length, rather than the 5:1 ratio specified in the method.
2) A width range of 0.25 to 3 µm will be used when counting PCMe structures, rather than the 0.2 to 3 µm specified in the method.
3) A minimum of ten grid openings will be counted, rather than the minimum of four (4) grid openings specified in the method.
4) Calculations shall be made based on total fibers rather than primary fibers.

(B) The maximum number of grid openings (GOs) to be counted to achieve the specified analytical sensitivity shall be estimated as follows:

Number of GOs = EFA ÷ (A_{GO} x V x S x CF)

where:
EFA = effective filter area (385 for a 25-mm filter)
A_{GO} = area of a grid opening (approximately 0.01 mm^2; actual value to be provided by the analytical laboratory)
V = volume of air sampled (in liters [L])
S = analytical sensitivity (structures per cubic centimeter [s/cc])
CF = conversion factor (1000 cc/L)

(C) Any air sample analysis that results in a “cannot be read (CBR)” determination from the analyst, or a “not analyzed (NA) or rejected” due to loose debris or uneven loading, shall be prepared by the laboratory, using an indirect preparation method, for TEM presence/absence analysis.

3.5 Data Evaluation for Risk-Based Air Threshold Samples

(A) General requirements:

1) Samples collected for comparison to risk-based air thresholds shall be evaluated based on the average (mean) concentration over the exposure duration.

2) All valid data shall be used to calculate daily and ten (10) day rolling averages.
3) For all projects a minimum of three (3) samples per day must have quantifiable data (not CBR or rejected). If less than three (3) quantifiable analytical results are available then the daily average is invalid.

(B) Project days 1-9:

1) The results of the daily samples must be averaged to calculate a daily average for use in comparing to the risk based air threshold for days 1-9 of monitoring.
2) A ten (10) day average shall be calculated for days 1-9. The ten (10) day average shall be comprised of at least eight (8) valid daily average results. However, all valid data shall be used to calculate the ten (10) day average.
3) If the ten (10) day average exceeds the risk-based air threshold, engineering controls shall be adjusted to reduce the daily average.
4) The Department shall be notified within 24 hours if the calculations in paragraphs 1 and 2 above cannot be completed due to invalid data.

(C) Project days 10 and greater:

1) Starting on day 10, a ten (10) day rolling average shall be calculated and compared to the risk-based threshold.
2) If average concentration trends indicate the risk-based air threshold will be exceeded before project completion, engineering controls shall be adjusted to reduce the daily asbestos emissions.
3) If subsequent evaluation of average concentration trends indicates that the risk-based air threshold will still be exceeded before project completion, additional adjustments to engineering controls shall be made.
4) If changes in engineering controls are not effective in reducing airborne concentration trends such that the risk-based air thresholds can be met, consultation with the Department is required.
5) The Department shall be notified within five (5) working days if the averaged airborne asbestos concentration for the entire project exceeds the risk-based air threshold.

4.0 Documentation

(A) All of the following sampling and analytical documentation shall be maintained during a project and available for Department review upon request. This documentation need not be submitted to CDPHE unless requested or as required in a project specific plan.

1) Documentation of bulk, soil, and ash samples shall include:

   a. A description of the material being sampled including friability.
      i. For samples collected for characterization purposes also include an estimate of the quantity of visible suspected RACS present.
      ii. For samples of ash, also include a brief description of the ash layer, and any associated identifiable debris.
   b. Name of person collecting the sample(s).
   c. Date and time of sample collection.
   d. Location of sample collection (a map, drawing, or diagram showing sample locations in relation to the work area and surrounding area).
   e. The boundary/limits that are represented by the collected sample.
   f. Chain of custody documentation.
   g. Laboratory analysis reports.
   h. Log of characterized homogeneous bulk materials including material descriptions, photographic documentation, and asbestos content.

2) Documentation of air samples shall include:

   a. Name of person collecting the sample(s).
   b. Date and time(s) of sample collection.
   c. Locations of air sample collection.
   d. Any relocation of air samples.
   e. A map, drawing, or diagram showing air sample locations (initial and relocations) in relation to the work area and the surrounding area.
   f. Chain of custody documentation.
   g. Laboratory analysis reports.
   h. Explanation of any air sample malfunctions and any voided air samples.
   i. Risk based air threshold concentration calculations.

j. Air sample data (flow rates, time of sampling, volumes, calibration method, etc.).
k. Wind speed measurements.
l. Prevailing wind directions.
m. Wind shut down events.
n. Observations of visible emissions and responses.

5.0 Deviations from Sampling and Analysis Procedures

(A) Deviation from this sampling and analysis appendix shall only be allowed upon consultation with, review by, and approval from, the Department.

APPENDIX C
GUIDANCE FOR REUSE OF SOIL ON CITY PROJECTS

DENVER
THE MILE HIGH CITY

Department of Environmental Health
Division of Environmental Quality
200 W 14th Ave, Suite 310
Denver, CO 80204
p: 720-913-1311
f: 720-865-5534
www.denvergov.org/deh

INTEROFFICE MEMORANDUM

TO: City and County of Denver Department Executive Directors

FROM: Bob McDonald, Executive Director

DATE: October 05, 2017

SUBJECT: Guidance for Reuse of Soil on City Projects

There is increasing demand in and around the City and County of Denver (City) for soil available for reuse. Such reuse offers several benefits to the City including reduced waste, hauling costs, disposal fees, and vehicle emissions.

As the local public health authority, the City's Department of Environmental Health (DEH) has determined that all reusable soil must be adequately characterized based on the intended reuse to ensure the protection of public health and the environment. If the soil is not suitable for reuse per these guidelines, it must be disposed at the City-owned Denver Arapahoe Disposal Site (DADS) in accordance with the City's Executive Order No. 115.

This guidance provides criteria by which City employees and/or third parties may, or may not, reuse soil from City projects at both City-owned properties and properties owned by others. DEH sign off will be required for any reuse options. As such, to promote safe and sustainable reuse, it is within DEH's purview to implement the following requirements for City soils to be reused:

1. For onsite reuse, City personnel are responsible for contacting DEH[1] when they want to reuse soil or receive a request to reuse soil. DEH is responsible for promptly informing the requestor of City sampling frequency and analysis requirements based on contaminants of concern from recognized environmental conditions, which are designed to promote safe and sustainable reuse.

2. For off-site reuse and/or material to be imported to a site, the person or entity requesting to reuse the soil must adequately characterize the soil by sampling at least every 500 cubic

[1] Diane DeLillio, 720-865-5448, diane.delillio@denvergov.org

311 for City Services
Denver gets it done!

DENVER
THE MILE HIGH CITY

Department of Environmental Health
Division of Environmental Quality
200 W 14th Ave, Suite 310
Denver, CO 80204
p: 720-913-1311
f: 720-865-5534
www.denvergov.org/deh

yards to be excavated (or alternative frequency as determined by DEH) and analyze those soil samples for, at a minimum:

a. Volatile organic constituents;
b. Semi-volatile organic constituents;
c. Total petroleum hydrocarbons;
d. Pesticides;
e. Herbicides;
f. Polychlorinated biphenyls (PCBs);
g. Arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver; and
h. Asbestos – if debris is found and if suspect asbestos-containing material is found in the debris (e.g., transite, ash, brick mortar, asphalt shingles, etc.)

3. In general, the person or entity requesting to reuse the soil shall pay all costs associated with the sampling and analysis of the soil.

4. Before the City will release the soil for reuse, the party requesting the excess soil must indicate the land use of the accepting site and demonstrate to DEH's satisfaction that the soil meets the criteria based on the designated land use of the receiving site. See Exhibit 1 for additional guidance.

5. Maintain the documentation for sample collection, analytical results, and the environmental consultant's field notes and evaluation.

6. Any third party will be required to sign a release to accept the soil from the City and to release the City from liability.

Attachments: Exhibit 1 – Soil Reuse Acceptance Criteria Guidance Table
Exhibit 2 - Draft Release for Third Party Acceptance

CC: Jessica Brody, CAO
Lee Zarzecki, CAO
Zachery Clayton, DEH
Gregg Thomas, DEH

311 for City Services
Denver gets it done!

DENVER
THE MILE HIGH CITY

Department of Environmental Health
Division of Environmental Quality
200 W 14th Ave, Suite 310
Denver, CO 80204
p: 720-913-1311
f: 720-865-5534
www.denvergov.org/deh

Exhibit 1 - Soil Reuse Acceptance Criteria Guidance Table

Land Use	Examples	Applicable Soil Reuse Acceptance Criteria*
Recreational	Parks, Open Space	All Contaminants except Arsenic (Residential) Arsenic Standard
Residential	Single Family, Multi-family, Mixed-use with residential component	All Contaminants except Arsenic (Residential) Arsenic Standard
Right of Ways (not inclusive of utilities)	Roads, sidewalks, bike paths	All Contaminants except Arsenic (Composite Worker) Arsenic Standard
Utility corridors (underground)	Storm water, Waste water,	All Contaminants except Arsenic (Composite Worker) Arsenic Standard
City-owned facilities	Maintenance garages, office buildings, safety buildings	All Contaminants except Arsenic (Composite Worker) Arsenic Standard

* Screening values presented in the Regional Screening Levels table are based on human health risk from the combined exposure of direct soil ingestion, dermal contact with soil and inhalation of vapors or particulates associated with soil. Other pathways, such as indoor air or groundwater protection, may need to be considered on a site-specific basis. Some sites in sensitive ecological settings may need to be evaluated for potential ecological risk. These screening levels may not be applicable to sites within and/or subject to other regulatory programs (i.e., RCRA Corrective Action, Leaking Underground Storage Tanks, Superfund Operable Unit, etc.)

In addition, the reuse of any regulated asbestos-containing soil ("RACS") or suspect-RACS must be conducted in accordance with state regulations governing the management of RACS, 6 CCR 1007-2, § 5.5.

DEH is committed to assisting all agencies and projects to perform soil disturbing activities in a cost-effective and sustainable manner while ensuring protection of public health and the environment.

311 for City Services
Denver gets it done!

PRIVILEGED AND CONFIDENTIAL/ATTORNEY WORK PRODUCT

AGREEMENT AND RELEASE FOR EXCESS SOIL REUSE

This Agreement and Release ("Agreement") is made by and between _____ (the "Accepting Party") and the City and County of Denver (the "City") (collectively, the "Parties").

RECITALS

WHEREAS, the City has determined that it has excess soil available; and

WHEREAS, the Accepting Party has requested excess soil from the City for reuse at ___[address of reuse location]___; and

WHEREAS, the Accepting Party has sampled and analyzed the excess soil and determined it to be suitable for the intended reuse; and

NOW, THEREFORE, in consideration of the premises and agreements contained herein, the Parties agree as follows:

1. Recitals Binding. The Parties agree that the Recitals stated above are an integral part of the Agreement and are binding.

2. Conveyance of Ownership. The City agrees to convey to the Accepting Party ownership of up to __[maximum volume]__ cubic yards of excess soil.

3. Acceptance "AS-IS". The Accepting Party acknowledges that the City has made no representations or warranties regarding the environmental or geotechnical suitability of the excess soil. The Accepting Party acknowledges that it is assuming ownership of the excess soil based solely on its analysis of the soil. The Accepting Party accepts the excess soil "AS IS."

4. Payment. The Accepting Party shall pay to the City good and valuable consideration in the amount of TEN DOLLARS ($10.00), the sufficiency of which is hereby acknowledged.

5. Transportation to Receiving Site. The Accepting Party will transport, or arrange to transport, the excess soil from __[address]__ to the reuse location at a time, place, and manner acceptable to the City.

6. Defense and Indemnification

a. The Accepting Party agrees to defend, indemnify, reimburse and hold harmless City, its appointed and elected officials, agents and employees for, from and against all liabilities, claims, judgments, suits or demands for damages to persons or property arising out of, resulting from, or relating to the reuse of the excess soil, unless such Claims have been specifically determined by the trier of fact to be the sole negligence or willful misconduct of the City.

b. Accepting Party's duty to defend and indemnify City shall arise at the time written notice of the Claim is first provided to City regardless of whether Claimant has filed suit

on the Claim. Accepting Party's duty to defend and indemnify City shall arise even if City is the only party sued by claimant and/or claimant alleges that City's negligence or willful misconduct was the sole cause of claimant's damages.

c. Accepting Party shall defend any and all Claims which may be brought or threatened against City and shall pay on behalf of City any expenses incurred by reason of such Claims including, but not limited to, court costs and attorney fees incurred in defending and investigating such Claims or seeking to enforce this indemnity obligation. Such payments on behalf of City will be in addition to any other legal remedies available to City and will not be the City's exclusive remedy.

7. City Execution of Agreement. The Agreement will not be effective or binding on the City until it has been fully executed by all required signatories of the City and County of Denver, and if required by Charter, approved by the City Council.

8. Authority.

a. The Parties to this Agreement agree that each Party has authority to execute this Agreement.

b. The Parties to this Agreement have carefully read, and know and understand, the full contents of this Agreement and are voluntarily entering into this Agreement.

c. The Parties to this Agreement are competent to enter into this Agreement.

9. Governing Law and Venue. The Agreement will be construed and enforced in accordance with applicable federal law, the laws of the State of Colorado, and the Charter, Revised Municipal Code, ordinances, regulations and Executive Orders of the City and County of Denver, which are expressly incorporated into the Agreement. Unless otherwise specified, any reference to statutes, laws, regulations, charter or code provisions, ordinances, executive orders, or related memoranda, includes amendments or supplements to same. Venue for any legal action relating to the Agreement will be in the District Court of the State of Colorado, Second Judicial District (Denver District Court).

10. Entire Agreement: The Parties to this Agreement have not relied on any statement, representation, omission, inducement or promise of any other Party (or any officer, agent, employee, representative, or attorney for any other Party) in executing this Agreement, or in making the settlement provided for herein, except as expressly stated in this Agreement. The Agreement contains the entire understanding of the Parties relating to the subject matter of the Agreement. No promise, inducement or agreement which is not specifically provided in this Agreement has been made by any party to this Agreement, and no warranties, representations, or undertakings are made by the Parties hereto except as are expressly provided herein.

11. Electronic Signatures and Electronic Records. The Accepting Party consents to the use of electronic signatures by the City. The Agreement, and any other documents requiring a signature under the Agreement, may be signed electronically by the City in the manner specified by the City. The Parties agree not to deny the legal effect or enforceability of the Agreement solely because it is in electronic form or because an electronic record was used in its formation. The

Parties agree not to object to the admissibility of the Agreement in the form of an electronic record, or a paper copy of an electronic document, or a paper copy of a document bearing an electronic signature, on the ground that it is an electronic record or electronic signature or that it is not in its original form or is not an original.

[Remainder of the Page Intentionally Left Blank]

[Signature Pages Follow]

DRAFT

SECTION 01 56 39 TREE RETENTION AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Report Documentation
1. City and County of Denver – Standard Materials Management Plan (MMP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, November 13, 2019 (see Appendix A).
2. City and County of Denver - Regulated Asbestos Contaminated Soil Standard Operating Procedure (RACS SOP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, May 2, 2019 (see Appendix B).
3. City and County of Denver – Guidance for Reuse of Soil on City Projects, Denver Department of Environmental Health – Environmental Quality Division, October 5, 2017 (see Appendix C).

1.2 SUMMARY

A. This section consists of retention and protection of trees during the construction of the project.

B. Related Sections:
1. Division 01 Section “Erosion and Sedimentation Control”.
2. Division 02 Section “Demolition”.
3. Division 31 Section “Clearing and Grubbing”.
4. Division 32 Section “Concrete Walks, Curbs, and Miscellaneous Flatwork”.
5. Division 32 Section “Irrigation Systems”.
6. Division 32 Section "Native Seeding”.
7. Division 32 Section "Sodding”.

1.3 DEFINITIONS AND REFERENCE STANDARDS

A. Office of the City Forester (OCF): The City division within Denver Parks and Recreation responsible for all trees in public parks, parkways, right-of-way, and other public property.

B. Caliper Inch: The diameter of a tree six (6”) inches above the root flare. The root flare is where the first main roots attach to the trunk.

C. Licensed, and Insured Arborist: A person shall be licensed and insured by the City and County of Denver per the City Ordinance, Chapter 57.71 to cut, trim, prune, or remove trees.

D. Champion Tree: The largest specimen of its species as determined by American Forests measuring guidelines, and as recorded with either the Colorado Tree Coalition, or the National Register of Champion Trees. In the specification herein, Champion Tree(s) shall be referred to as Notable Tree(s).

E. Diameter at Breast Height (DBH): The diameter of a tree measured at four and a half feet (4.5') above finished grade.

F. Drip Line: The outermost edge of the tree's canopy or branch spread. The area within a tree's drip line is all the ground under the total branch spread.

G. Established Tree: Trees on public property in fair or better condition with a trunk six inches (6") in diameter or greater.

H. Exploratory Excavation: A method approved by the Office of the City Forester to determine the amount and size of tree roots under the surface. Methods may include hand excavation, a pneumatic air excavation tool, or water excavation.

I. Water Excavation: Hydrovac excavation that utilizes high-pressure water to cut and liquefy the soil, while simultaneously using a vacuum to remove the soil from the excavation and will require that import fill is brought to the site to fill trenches after excavation.

J. Impacted by Construction: Trees that are directly within or adjacent to the Limit of Work, within or adjacent to staging/storage areas, and within or adjacent to construction access areas that are affected in a negative way.

K. Invasive Tree Species: Species that are on the Colorado State List for Noxious Weed Species. Anything on the A, B, or C list needs to be evaluated by the Office of the City Forester for suitability.

L. Notable Tree: Trees on public property of species rare to the City and County of Denver, including but not limited to size, form, shape, beauty, age, color, rarity, genetic constitution, or other distinctive features; of the earliest known plantings; associated with a historic person, place, event, or period; associated with local folklore, myth, legends, or traditions; and of large diameter, height or canopy spread. In the specification herein, Notable Tree(s) will be used to describe both Champion Tree(s), and Tribute Tree(s).

M. Project Consulting Arborist: An independent consultant with a degree in forestry, horticulture, arboriculture, plant pathology, entomology or plant biology; an American Society of Consulting Arborists (ASCA) registered consulting arborist, or an International Society of Arboriculture (ISA) Board Certified Arborist, with at least five (5) years of field experience, including tree preservation or on-site monitoring of public works or construction projects involving tree retention and protection. The Project Consulting Arborist shall be approved by the Office of the City Forester.

N. Pneumatic Air Excavation Tool: A tool specifically designed to excavate soil from around tree roots. Air Spade or Air Knife are examples of pneumatic air excavation tools.

O. Significant Tree: Trees on public property with a trunk twelve inches (12") in diameter at breast height (DBH) or greater or designated by the Office of the City Forester.

P. Suitability: The quality of a tree or trees appropriate for protection and preservation during construction projects. This quality is based on an assessment of tree health, structure, age, species factor and risk assessment, if pertinent.

Q. Tree Protection Work Plan: The tree protection plan is a plan based on the contract drawings that includes the Contractor's approach to working within and around the Tree Protection Zones.

R. Tree Protection Zone (TPZ): The Tree Protection Zone is the area above and below grade around each tree where construction activities are limited or restricted to preserve tree health and structural integrity of the protected trees.
1. The diameter of the tree shall be measured at four and one-half feet (4.5') above grade (referred to as diameter breast height). For every-one inch (1") of tree diameter the Tree Protection Zone shall extend one foot (1.0') radially from the base of the trunk or be placed at the dripline, whichever is **greater**.
2. Notable Tree protection shall be for every one inch (1") of tree diameter the Tree Protection Zone shall extend one- and one-half feet (1.5') radially from the base of the trunk, or as determined by the Office of the City Forester and include chain link fencing.
3. For areas with groups or groupings of trees, if the distance between trees is less than thirty feet (30'), the Tree Protection Zone may be combined and treated as one contiguous area to create a more clearly defined and manageable Tree Protection Zone.

S. Tribute Tree: A living dedication for an occasion like a birth, wedding, anniversary, or to remember someone close to you. In the specification herein, Tribute Tree(s) shall be referred to as Notable Tree(s).

1.4 SUBMITTALS

A. All Submittals shall be approved by the Project Manager and the Office of the City Forester or the Project Consulting Arborist, prior to mobilization and any Work being conducted on site.

B. Tree Protection Work Plan: Submit a tree protection work plan based on the Contract Drawings for approval. The plan shall include the following:
1. Existing conditions.
2. Limit of Work.
3. Tree caliper / diameter size, location of dripline, and City site identification number.
4. Tree Protection Zones with Tree Protection Zone sign locations.
5. Tree protection fencing (chain link / orange plastic safety) shall correspond to the level of construction activity adjacent to protected tree(s). Including but not limited to areas of high traffic, material drop off/pickup, high intensity activity, and earthwork of greater intensity than grubbing. Notable trees shall include chain link fencing.
6. Plan for the Work occurring within or adjacent to Tree Protection Zones:
    a. Access routes, including designated routes for equipment and foot traffic by work crews to minimize soil compaction.
    b. Proposed exploratory excavation locations and methods to remove soil from around tree roots within Tree Protection Zones.
7. Maintenance of Tree Protection Zones and any trees affected by Construction during the Work.
8. Trees identified for regular soil moisture readings.
9. During construction, Tree Protection Plans may need to change per field conditions. The Contractor shall continue to update the Tree Protection Work Plan in the field as a redlined plan and submit for approval from the Project Manager and the Office of the City Forester.

C. Tree Protection Work Plan Updates: The Contractor shall submit a highlighted section of their Tree Protection Work Plan at the Construction Progress Meetings to discuss where they intend to work and what Tree Protection Zones may be impacted for the upcoming week.

D. Pruning: Proposed methods, materials, the Licensed and Insured Arborist, and schedule for root pruning, branch pruning, and other tree maintenance shall be submitted for approval.

E. Pneumatic Air Excavation: Type of pneumatic air excavation tool, the Licensed and Insured Arborist, and schedule for excavation shall be submitted for approval.

F. Water Excavation: Type of hydrovac excavation tool, the Licensed and Insured Arborist, and the schedule for excavation shall be submitted for approval.

G. Watering Plan and Schedule: The Contractor shall submit a watering plan and schedule prior to the start of work that details watering of all trees affected by the Project for approval. The below information shall be included:
   1. Area of the project site to be watered and how watering will be phased based on construction.
   2. Location, City site identification number (SID), and caliper inch of each tree to be watered.
   3. Total number of trees to be watered and total caliper inches. Identify the amount of water to be applied based on total caliper inches
   4. Schedule for watering during the duration of the project.
   5. How the trees will be watered:
      a. On-site irrigation system.
      b. Temporary above ground irrigation system
      c. Hydrant.
      d. Water truck.
      e. Combination of on-site irrigation, hydrant, and water truck.

H. Soil Moisture and Watering Log: The Contractor shall fill out and submit the Office of the City Forester watering log, attached as an Exhibit. Information on the watering log includes:
   1. Tree(s) watered, identified by the City site identification number.
   2. Number of gallons of water applied to each tree during every watering period or irrigation schedule.
   3. Soil moisture level readings, on a scale of one to ten (1 – 10). Refer to Part 3 - Execution for soil moisture reading requirements.
   4. Dates of each watering.
   5. The Soil Moisture and Watering Log shall be provided monthly via email to the Office of the City Forester and the Project Manager and reviewed at Construction Progress Meetings prior to the submittal of Pay Applications. Pay Applications will not be approved without receipt of the Soil Moisture and Watering Logs. If there appears to be an issue with on-site watering, Soil Moisture and Watering Logs may be requested at any time by the Office of the City Forester. It's expected that these are updated per the Specifications to reflect on-site watering.

1.5 QUALITY CONTROL

A. The Contractor and all their sub-contractors shall attend a Preconstruction Meeting as outlined in Division 01 "Project Meetings". When the Project requires new sub-contractors to be on-site

to complete Work, the Contractor shall include the sub-contractors in the Construction Progress Meetings to review the requirements of this specification.

B. Contractor shall comply with applicable requirements and recommendations of the most current versions of the following standards and guidelines. Where these conflict with other specified requirements, the more restrictive requirements shall govern.
   1. ANSI Z133.1: American National Standard for Tree Care Operations.
   2. ANSI A300: Tree, Shrub, and Other Woody Plant Management – Standard Practices – Parts - 1,2,5,6 and 8.
   3. Guide for Plant Appraisal – Current Edition: Authored by the Council of Tree and Landscape Appraisers; published by the International Society of Arboriculture.

C. As established by Chapter 57 of the Denver Revised Municipal Code, the City Forester, or an approved designee from the Office of the City Forester, shall be responsible for ensuring that all construction activities are in compliance with established standards for protection, removal, maintenance, and planting of trees with the goal of promoting the health, safety, welfare, and quality of life of the residents of the city through the development of a sustainable community forest and, specifically, the preservation of trees.

D. At its discretion, the City may hire a Project Consulting Arborist to conduct daily observation of the Contractor's field crews during the critical phases of the project, including, but not limited to, demolition of existing concrete, root pruning, construction of retaining walls, irrigation, and construction of new curb or sidewalk in Tree Protection Zones.

E. Motorized equipment and trailers, including but not limited to tractors, skid loaders, bulldozers, rubber-tired excavators, tracked excavators, trucks, cars, and carts shall not be allowed access within Tree Protection Zones with the exception of paved surfaces. Should access be necessary within designated Tree Protection Zones the Office of the City Forester or Project Consulting Arborist shall be notified and shall approve of the access route and driving surface prior to its use.

F. Materials, supplies, tools, and construction facilities shall not be stockpiled or stored within the Tree Protection Zones unless otherwise approved by the Office of the City Forester. Should temporary storage be approved by the Office of the City Forester within designated Tree Protection Zone(s), the existing grade shall be covered with plywood as identified in Part 3 – Execution to help distribute the weight of equipment and to minimize soil compaction and rutting. Plywood and/or mulch are not acceptable bridging materials for driving over exposed tree roots.

G. Under no circumstances shall any objects or materials be leaned against or supported by a tree's trunk, branches, or exposed roots. The attachment or installation of any sign, cable, wire, nail, swing, or any other material to trees that is not needed to help support the natural structure of the tree is prohibited. Standard arboricultural techniques such as bracing or cabling that are performed by professional arborists are acceptable upon approval of the Office of the City Forester or Project Consulting Arborist.

H. The Contractor shall notify the Office of the City Forester prior to mobilization on site with their schedule for installation of tree protection. Tree protection shall be in place and approved prior to any work being conducted on-site, this includes erosion control.

I. The Office of the City Forester is not available for inspections and approval on weekends or holidays, unless previously approved by the Project Manager and the Office of the City Forester.

J. If there is any known environmental contamination on-site, the Contractor shall coordinate with the Denver Department of Public Health and Environment (DDPHE) and follow the City and County of Denver guiding documents.

PART 2 - PRODUCTS

2.1 TREE PROTECTION FENCE

A. Orange plastic safety fencing – minimum of forty-eight inches (48") in height, heavy duty T-posts.
   1. Twelve (12) gauge wire.

B. Galvanized Chain-link – Six feet (6') in height. Steel chain link fence panels or rolls are acceptable.

C. Tree Protection Zone signs printed and laminated by the Contractor. Refer to Appendix.

2.2 EXPLORATORY EXCAVATION

A. Pneumatic Air Excavation Tool, AirSpade, Air Knife, or approved equal. The tool used shall not exceed ninety pounds per square inch (90 PSI).

B. Water Excavation Tool, Hydrovac equipment. The tool shall not exceed sixty pounds per square inch (60 PSI) and shall utilize a rotary nozzle to minimize root damage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Contractor shall follow the approved Tree Protection Work Plans and access routes.

B. If it appears any Work may cause damage to a tree, the Contractor shall contact the Project Manager and the Office of the City Forester. The Project Manager and Office of the City Forester will make the determination as to whether such damage is likely, and the next steps.

C. Methods for working within a Tree Protection Zone shall be approved prior to the start of work and may include the following depending on project site conditions:
   1. Pneumatic air excavation tool. Maximum pressure applied shall be an amount not to damage roots and shall not exceed ninety pounds per square inch (90 PSI). Pneumatic air excavation may not be allowed when in known asbestos areas.
   2. Water excavation. Maximum pressure applied shall be an amount not to damage roots and shall not exceed sixty pounds per square inch (60 PSI). Water excavation may be required when in known asbestos areas.
   3. Directional boring.

4. Hand digging.
5. Other methods approved by the Office of the City Forester.

3.2 TREE PROTECTION FENCING

A. Tree protection fencing shall be installed and approved by the Office of the City Forester prior to any site activity, including installation of erosion control, and shall remain in place and maintained in the condition in which it was approved until removal is authorized by the Project Manager and the Office of the City Forester.

B. Tree protection fencing shall be installed one foot (1') offset from the existing or proposed hardscape.

C. Tree protection fencing shall be constructed as follows:
1. Fencing shall be installed to surround the trees within the Limit(s) of Work.
2. Orange plastic safety fencing is required as shown in the plans or as directed by the Office of the City Forester.
    a. The fencing shall be secured to metal t-posts with twelve-gauge (12) wire woven through the top of fencing along the entire length.
    b. Heavy duty t-posts shall be placed every eight feet (8') so that wire and fence are taut.
    c. Installation of the posts shall not result in injury to the tree above or below ground.

3. Chain link fencing is required by the Office of the City Forester, particularly where heavy construction activity is adjacent to existing trees, where Notable trees are located, or as required on the plans.
    a. Chain link fence shall have posts installed no less than ten feet (10') on center, at a depth of twenty-four inches (24") minimum or utilize sandbags as shown in the Tree Retention and Protection Detail.
    b. Installation of the posts shall not result in injury to tree above or below ground.

3.3 TREE PROTECTION SIGNS

A. A standard Office of the City Forester tree protection sign shall be placed one (1) per each Tree Protection Zone, minimum, or per the direction of the Office of the City Forester.
1. The Contractor shall print and laminate eleven by seventeen-inch (11"x17") size tree protection signs. Refer to Appendix.
    a. The Contractor shall use zip ties on all four (4) corners of the signs to attach to the tree protection fencing.
    b. The tree protection signs shall be replaced within twenty-four (24) hours if they become unreadable, destroyed, missing, or per the direction of the Project Manager and/or the Office of the City Forester.

3.4 DEMOLITION

A. Caution shall be used during removal of existing street, curb, gutter, sidewalk, drain inlets, and other concrete and asphalt demolition, to minimize injury to tree root systems. The following procedures are acceptable when removing existing concrete.
1. Breaking of the existing concrete and asphalt for removal shall be done in a manner that will minimize ground disturbance and vibration.

2. Curbs and sidewalks within designated Tree Protection Zones shall be removed in a manner approved by the Office of the City Forester. When removing existing sidewalks and curbs, care shall be taken to avoid injury to roots located under, over, or adjacent to paved surfaces.
3. In instances where roots and root-trunk flares are growing over hardscape, caution shall be used to minimize damage during breaking of hardscape and removal of debris. Wood and bark tissues shall not be injured by equipment. The Contractor shall discuss methods and submit for approval from the Office of the City Forester prior to demolition.
4. Motorized equipment and trailers, including but not limited to tractors, skid steers, bulldozers, rubber-tired excavators, tracked excavators, trucks, cars, and carts are limited to existing paved areas only and access must be approved by the Office of the City Forester prior to entrance into the Tree Protection Zones.
    a. If pre-approved by the Office of the City Forester, the Contractor shall test compaction after removal of hardscape to determine the percent of Standard Proctor. If the Standard Proctor is ninety percent (90%) or above, the Contractor may be able to utilize the tested area with equipment as approved by the Office of the City Forester. If it is determined that the compaction is adequate, but there are visible surface roots or tree roots that will be impacted, this method may not be suitable and may be denied by the Office of the City Forester.
    b. If equipment is approved by the Office of the City Forester, tracking pads shall be placed on the surface.
5. All excavation and debris material shall be hauled off or deposited outside of the Tree Protection Zones. At no time shall material be stored, even temporarily, within the Tree Protection Zones.

3.5 CONSTRUCTION IN TREE PROTECTION ZONES

A. The Contractor shall protect all trees from injury due to construction related work. All injuries to trees shall be mitigated to the satisfaction of the Office of the City Forester, and, if appropriate in accordance with guidelines established in the "Guide for Plant Appraisal" as available upon request from the Office of the City Forester. All costs of such mitigating shall be charged to and paid by the Contractor or offending sub-contractor.

B. If access within designated Tree Protection Zones is approved by the Office of the City Forester or Project Consulting Arborist, the existing grade shall be covered with twelve inches (12") of wood mulch and overtopped by three-quarter inch (3/4") plywood with overlapping sheets, six-inches (6") minimum, or the plywood may be approved for use on the bottom of the mulch, to help distribute the weight of equipment and to minimize soil compaction and rutting. Mulch must be maintained at twelve inches (12") and plywood must be replaced when it becomes damaged and cracked to the point of being ineffective as determined by the Office of the City Forester.
    1. Ground tracking mats or steel plates may be used as an alternative to plywood and may be required in high-traffic areas. Mulch is still required in combination with ground tracking mats or steel plates. Mats or plates must be appropriately sized for the type of equipment and shall be approved by the Project Manager of Office of the City Forester prior to installation.

C. The following procedures shall be used when constructing any hardscape or drainage improvements:
    1. All materials and equipment shall be kept on existing hardscape or within previously approved, compacted sub-base areas.

2. Protect exposed roots from damage and contamination by stabilization materials and concrete.
3. Locate concrete washouts outside of and away from Tree Protection Zones. Washout runoff shall be strictly contained within the washout area and shall not flow into Tree Protection Zones.
4. When excavating, excavated soil shall be deposited in trucks and hauled off or deposited temporarily outside the Tree Protection Zones. Excavated and fill soil shall not be deposited, even temporarily, in Tree Protection Zones.
5. If root pruning is needed, refer to section "Pruning".

D. The compaction of sub soil within Tree Protection Zones shall not exceed eighty percent (80%) proctor density, unless the Contractor can confirm by testing that the existing compaction within the Tree Protection Zones already exceeds eighty percent (80%).

E. If part of an approved plan, grading within the Tree Protection Zones shall be performed by hand or a method approved by the Office of the City Forester. Any fill material that needs to be placed in the Tree Protection Zone shall be limited to a maximum of four inches (4") of fill material over the area. Fill should consist of sandy loam topsoil. Clay soils shall not be used as fill. When using fill soil, the existing surface to receive fill should be scarified by hand, while avoiding root damage, to a maximum depth of one inch (1") from the finished grade prior to placing fill material, to ensure proper incorporation of fill material. Any filling operation should not occur during water saturated soil conditions.

F. Concrete or chemicals spilled within Tree Protection Zones shall be completely removed at the time of the spill. Contaminated soil shall be completely removed by hand and/or approved methods to minimize disturbance to root systems. Approved soil shall be added as necessary to restore the grade and the Contractor shall provide remedial tree maintenance as outlined in section "Tree Maintenance During Construction". Contact the Project Manager and the Office of the City Forester immediately in the event of a spill within a Tree Protection Zone

3.6 TRENCHING

A. When trenching is approved within the Tree Protection Zones by the Office of the City Forester, the Work shall be dug by hand, pneumatic air excavation, water excavation, or be done by directional boring in a matter to minimize root damage.

B. Whenever trenching exposes roots, as called out in section "Pruning", extending through the trench wall, the Contractor shall contact the Project Manager and the Office of the City Forester or the Project Consulting Arborist immediately for inspection and evaluation. Refer to section "Pruning".

C. Directional Boring: Bore shall be thirty-six inches (36") below grade, minimum for irrigation mainline and site utilities, unless otherwise approved by the Office of the City Forester or the Project Consulting Arborist. For irrigation lateral lines the depth shall be between eighteen inches (18") and twenty-four inches (24"). The bore shall have a locator to measure and maintain depth. The Contractor shall verify depth is accurate with the Project Manager and the Office of the City Forester.

3.7 IRRIGATION OR UTILITY INSTALLATION

A. All Excavation, Irrigation, or Utility installation occurring within the Tree Protection Zones as indicated on the Contract Documents shall be marked out in the field and reviewed in the field with the Office of the City Forester or Project Consulting Arborist prior to installation.

3.8 PRUNING

A. Branch Pruning: Shall be the responsibility of the Contractor for construction equipment access, specialty pruning required for the Project, and any damage caused by the Contractor during the Project and shall be done by a Licensed, and Insured Arborist. Pruning shall only be done with approval and at the direction of the Office of the City Forester or Project Consulting Arborist. Information on storm damage is found in section "Tree Maintenance During Construction".

B. Root Pruning: Shall be done in accordance with ANSI A300 Root Management Standard latest edition and in accordance with Best Management Practices and be performed by a Licensed, and Insured Arborist.
   1. The Office of the City Forester or Project Consulting Arborist shall be notified prior to any Work operation known or suspected to involve cutting of roots within the Tree Protection Zone. Tree roots shall not be pruned or cut unless their removal is unavoidable and shall be authorized by the Office of the City Forester.
      a. When contacting the Office of the City Forester, provide the following information:
         1) Tree type and/or City site identification number.
         2) Condition of the tree.
         3) Percent of disturbance anticipated within the Tree Protection Zone.
         4) Size of roots.
   2. All roots needing to be pruned or removed shall be cut cleanly with sharp hand tools, with oversight by the Office of the City Forester or the Project Consulting Arborist. No wound dressings shall be used. Backfill shall promptly be installed over the exposed roots, filling all voids.
   3. Recommended root pruning tools shall be free of defects and have sharp cutting edges
      a. Scissor-type lopper.
      b. Scissor-type pruner.
      c. Pruning saws designed specifically for tree work.
   4. After root-pruning, cover exposed roots within thirty (30) minutes to minimize desiccation. Roots may be covered with soil, mulch, or moistened burlap, and shall be kept moist until the final grade is established or roots are buried in soil.
   5. Where appropriate, and under the direction of the Office of the City Forester or the Project Consulting Arborist, root restricting barriers can be installed in accordance with manufacturer's recommendations.
   6. If root pruning is authorized within the Tree Protection Zones, the Contractor shall provide remedial tree maintenance as identified in section "Tree Maintenance During Construction".

3.9 SURFACE AND EXPOSED ROOTS

A. When encountered, exposed roots shall be worked around in a manner that does not damage the outer layer of the root surface or bark
   1. The Office of the City Forester shall be notified should tree roots become exposed.

2. Exposed roots must be wrapped in burlap and kept moist. At or below forty degrees (40°) F, the excavation area shall be covered in concrete blankets or as directed by the Office of the City Forester.
3. Exposed tree roots shall not be driven over. Plywood and/or mulch are not acceptable bridging materials for driving over exposed roots.

3.10 PROJECT SITE MONITORING

A. The Contractor is responsible for monitoring and maintaining Tree Protection Zones throughout the duration of the Project until removal of the tree protection fencing is approved by the Project Manager and the Office of the City Forester.

3.11 TREE MAINTENANCE DURING CONSTRUCTION

A. Common Tree Maintenance: Practices that maintain the health and vigor of the tree, such as: watering, mulching, remedial pruning (if needed, and approved by the Office of the City Forester). The Contractor shall be responsible for all trees impacted by Construction throughout the Project.

B. Remedial Tree Maintenance: Practices such as soil remediation and soil/tissue sampling, and these practices are on an "as needed" basis, or as directed by Project Manager and the Office of the City Forester. The Contractor shall be responsible for all trees impacted by Construction throughout the Project.

C. Tree watering during Construction shall consist of the following minimum requirements for all trees within a Tree Protection Zone or otherwise impacted by Construction:
1. Watering of trees shall occur throughout the year during Construction, including winter.
2. Watering from May through September (growing season) shall consist of:
    a. All trees within the Limit of Work and/or impacted by Construction shall be watered.
    b. When utilizing the existing irrigation system, the Contractor shall continue to water per the current Denver Parks and Recreation watering schedule with a minimum of three (3) times per week during peak season.
3. Watering from October through April (winter) shall consist of:
    a. Trees six inches (6”) and smaller within the Limit of Work and/or impacted by Construction shall be watered.
    b. All evergreens within the Limit of Work and/or impacted by Construction shall be watered.
    c. Frequency shall be based on soil moisture readings, visual indicators, and weather conditions.
4. When completing winter watering or growing season watering with a hydrant or water truck, minimum watering requirements shall be twenty-five (25) gallons of water per caliper inch of every tree with an equal application of water throughout the entire Tree Protection Zone. Watering shall occur when daytime temperatures are at or above forty degrees (40°) F.
5. Watering frequency shall be based on the criteria above, visual indications, and on the average soil moisture level.
    a. The Contractor shall take soil moisture readings throughout the Project. The soil moisture shall have a measure between four (4) and eight (8) on the meter and shall be maintained during Construction.

b. Soil moisture readings shall be taken every week, at a minimum, during the Construction period and at a depth of twelve inches (12”).
c. Readings shall be taken and recorded for twenty percent (20%) of the trees within the Limit of Work and impacted by Construction and shall be indicated on the Tree Protection Work Plan.
d. All readings shall be recorded and submitted as outlined in Part 1 – Submittals.

6. Depending on weather conditions, the Office of the City Forester or Project Consulting Arborist may approve less frequent watering.
7. The Office of the City Forester will look for visual indications to determine if watering is adequate during Construction. If it appears that the trees are suffering based on visual indications, the Office of the City Forester will check the soil moisture levels and determine the corrective action. Criteria includes:
   a. The surrounding soil and/or landscape is dry.
   b. The surrounding vegetation is dying or dead.
   c. The leaves on the trees are wilted.
   d. Color.
8. Tree watering for non-irrigated sites: During the design process, the Consultant and the Project Manager shall work with the Office of the City Forester to determine the requirement for watering for non-irrigated sites based on specific project impacts and outline the criteria that shall be included within this specification.
9. At the Contractor’s expense, they may install a temporary irrigation system to water with the approval of the Project Manager and the Office of the City Forester.

D. Branch and Root Pruning: Refer to Section “Pruning”.

E. Maintenance for Storm Damage or Emergencies: The Contractor shall coordinate trees affected by storm damage with the Office of the City Forester. Guidelines for responsibilities are identified below:
1. Non-imminent threat or immediate threat that is not a danger to the public: Considered low priority clearing and will be removed as time allows by the Office of the City Forester. If the Contractor needs access to the Limit of Work, the Contractor shall remove the damage at their expense.
2. Immediate threat that affects the public: Considered high priority clearing for the Office of the City Forester and will be removed by the Office of the City Forester inside the Limit of Work.

F. The timing duration and frequency of necessary maintenance practices shall be determined and approved by the Office of the City Forester or Project Consulting Arborist, based on factors associated with the site and affected trees.

3.12 TREE PROTECTION ZONE VIOLATION AND DAMAGE PENALTIES

A. Verbal Warning: A verbal warning with instruction may be given at the discretion of the Office of the City Forester.

B. Written Warning: A written warning may be given at the discretion of the Office of the City Forester.

C. Fines: A fine of two thousand five hundred dollars ($2,500.00) will be levied against the Contractor or any Sub-contractor for each violation of the Tree Protection Zones and/or

damage. This includes but is not limited to, fencing not maintained as originally approved by the Office of the City Forester, and any encroachments within the designated Tree Protection Zones. Fines will be given for every occurrence and may exceed two thousand five hundred dollars ($2,500). This fine shall be independent of any applicable damage penalty for the appraised value of the tree(s).

D. Injuries and Damage to Existing Trees: Any plants designated as requiring retention or protection that are partially injured or lost due to Contractor neglect or unacceptable construction activities will result in a penalty as determined by the Office of the City Forester, as described in Chapter 57 of the Denver Revised Municipal Code.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement will be based on the percentage complete for the lump sum contract amount for Tree Retention and Protection.

4.2 PAYMENT

A. Payment will be made at the lump sum contract price, and shall include required materials, transportation, equipment, and labor, required to establish tree protection and remove the tree protection at the end of the project as required in accordance with the Contract Drawings and Specifications. Payment will also include the maintenance of the tree protection throughout the duration of the project as well as the labor, materials and equipment required to restore the site to its original condition at the completion of the project.

END OF SECTION 01 56 39

PART 5 - GENERAL

5.1 RELATED DOCUMENTS

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

5.2 SUMMARY

A. This Section includes the procedures and accuracy requirements for survey services for layout of work and field measurement of work quantities to be determined by surveys.
   1. The Work is to be verified and coordinated with Contract Drawings. Variations between Contract Drawings and actual field conditions are to be immediately brought to the attention of the Project Manager.
   2. Reference Standard Specifications for Construction General Contract Conditions, Article 318 “Construction Surveys” and Article 319 “Preservation of Permanent Land Survey Control Markers”.

5.3 SUBMITTALS

A. Refer to Division 01 Sections “Submittals” and “Shop and Working Drawings, Product Data, and Samples” for the submittal process.

B. Field Notes: Submit Copies of original pages of field notes.

C. Closeout Submittals:
   1. Original field notebooks when filled and at end of contract.
   2. Measurements for Record Documents.

PART 6 - PRODUCTS (Not Used)

PART 7 - EXECUTION

7.1 CONSTRUCTION LINES AND GRADES

A. The Contractor shall make surveys and layouts as necessary to delineate the work. The Contractor shall make the surveys for the proper performance of the Work. As a part of such surveys, the Contractor shall furnish, establish, and maintain in good order survey control points that may be required for the completion of the Work subject to the approval of the Project Manager as to their location, sufficiency, and adequacy. However, such approval by the Project Manager shall not relieve the Contractor of his responsibility for the accuracy of his survey work.

B. The Contractor shall furnish skilled labor, instrument platforms, ladders, and such other temporary structures as may be necessary for making and maintaining points and lines regarding the surveys required.

C. The City may draw the Contractor's attention to errors or omissions in lines or grades, but the failure to point out such errors or omissions shall not give the Contractor any right or claim nor shall in any way relieve the Contractor of his obligations according to the terms of this contract.

D. The Contractor's instruments and other survey equipment shall be accurate, suitable for the surveys required in accordance with recognized professional standards and in proper condition and adjustment always. Surveys shall be performed under the direct supervision of a Colorado licensed surveyor.

7.2 DIGITAL FILES

A. If approved by the Project Manager, the Contractor may elect to utilize the Design Consultant's digital CAD files as guidance for layout and location of site elements.

B. Layout and location of site elements, grades and features from digital CAD files does not relieve the Contractor of requirements, locations and grades shown on the Contract Drawings.

C. Contractor is responsible to verify locations of elements staked with digital data to assure conformance with the Contract Drawings at a level of accuracy as stated in Section 3.3 below.

7.3 SURVEYING ACCURACY AND TOLERANCES IN SETTING SURVEY, LAYOUT, AND QUANTITY CALCULATION STAKES

A. The tolerances generally applicable in setting survey stakes shall be as set forth in the CDOT's Survey Manual, latest edition. Such tolerances shall not supersede stricter tolerances required by the drawings or specifications and shall not otherwise relieve the Contractor of responsibility for measurements in compliance therewith.

7.4 RECORD MEASUREMENTS

A. Provide record measurement for items that will be hidden or visible including all civil, mechanical, and electrical, control work, and all utilities that are placed in concrete, earth, or behind walls shall be made.

B. Items located within or five feet (5') beyond a building shall be referenced to building column lines and finish floor elevations.

C. Special attention shall be paid to items requiring service, sensors, items with moving parts, access points and locations of junctions, elevation changes, and directional changes.

PART 8 - MEASUREMENT AND PAYMENT

8.1 MEASUREMENT

A. No separate measurement shall be made for work under this Section.

8.2 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Contract price.

END OF SECTION 01 71 23

SECTION 02 41 00 DEMOLITION

PART 9 - GENERAL

9.1 RELATED DOCUMENTS

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Report Documentation
1. City and County of Denver - Regulated Asbestos Contaminated Soil Standard Operating Procedure (RACS SOP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, May 2, 2019 (see Appendix).
2. City and County of Denver – Guidance for Reuse of Soil on City Projects, Denver Department of Environmental Health – Environmental Quality Division, October 5, 2017 (see Appendix).
3. **[City and County of Denver – Standard Materials Management Plan (MMP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, November 13, 2019 (see Appendix).]**
4. **[List geotechnical, investigative trenching, MMP, PSRMP or related documentation including dates, authorship, etc. (see Appendix).]**

9.2 SUMMARY

A. This Section includes the requirements for demolition and removal of:
1. Asphalt, concrete, and curbs.
2. Signs.
3. Abandoned utilities.
4. Miscellaneous site furnishings.

B. Related Sections:
1. Division 01 Section “Tree Retention and Protection”.
2. Division 01 Section “Erosion and Sedimentation Control”.
3. Division 31 Section “Clearing and Grubbing”.
4. Division 32 Section “Irrigation Systems”.

9.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to the City in a condition ready for re-use.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

E. Recyclable Material: Material generated during demolition operations that can be reconditioned and reclaimed for the same or different use. Such materials include asphalt, concrete, metals (steel, iron, aluminum, copper, etc.), rubber, glass and paper.

9.4 PROJECT CONDITIONS

A. Keep dust to a minimum at removal areas. Use water trucks as necessary.

B. Ensure safety of persons in demolition area. Provide temporary barricades as required per Division 01 Section "Temporary Facilities and Controls".

9.5 PRE-CONSTRUCTION MEETINGS

A. Inspect and discuss condition of construction to be selectively demolished.

B. Review structural load limitations of existing structure.

C. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

D. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

E. Review areas where existing construction is to remain and requires protection.

F. Additional agenda items as deemed necessary by the Contractor or the Project Manager.

9.6 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property [**, for environmental protection**] [**, for dust control**] [**and**] [**, for noise control**]. Indicate proposed locations and construction of barriers.

B. Schedule of Demolition Activities:
1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure the City's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.

C. Inventory: Submit a list of items to be removed and salvaged and deliver to the Project Manager prior to start of demolition.

D. Preconstruction Photographs or Video: Submit digital photographs or videos prior to Work commencing.

9.7 CLOSEOUT SUBMITTALS

A. Inventory:
1. Submit a list of items that have been removed and salvaged.
2. Include documentation of the type and volume/weight of materials hauled to the nearest recycling center.

B. Landfill Records: Provide records of receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

PART 10 - PRODUCTS

10.1 FILL MATERIALS

A. Soils as indicated on documents, free of debris, frozen materials, roots, and other organic matter. See Division 31 Section "Earth Moving".

PART 11 - EXECUTION

11.1 PREPARATION

A. Protect existing conditions to remain which may include but not limited to structures, pavement, trails, utilities, irrigation, landscape, trees and vegetation. Any damage to existing site conditions during construction shall be repaired or replaced at the Contractor's expense and to the satisfaction of the Project Manager.

B. Set up all barriers, including those for tree protection, in accordance with Division 01 Section "Temporary Facilities" and Division 01 Section "Tree Protection and Retention", prior to proceeding with any demolition.

C. Protection and Repair of Underground lines:
1. Existing Public Utilities: The Contractor shall have existing underground utilities located within the limits of work per General Contract Conditions, Article 804 Protection of Municipal, Public Service or Public Utility Systems. Request utility locates seventy-two (72) hours in advance of any excavations by calling the Utility Notification Center of Colorado at 811. The Contractor is responsible for providing written and graphical documentation from the utility owner. The Contractor shall take whatever precautions are necessary, including potholing, to verify location and depth to protect these underground lines from damage. Should unmarked or incorrectly marked utilities or other piping be encountered during excavation, notify the Project Manager immediately for direction. If damage does occur, all damage shall be repaired by the utility owner and all costs of such repair shall be paid by the Contractor. Only written all clears will be acceptable, verbal all clears will not be accepted.
2. Existing Private Utilities: The Contractor shall have existing underground utilities located within the limits of work per General Contract Conditions, Article 804 Protection of Municipal, Public Service or Public Utility Systems. The Contractor is required to contact all private utility companies, including The City and County of Denver departments, to locate all private utilities. The Contractor is responsible for providing written and graphical documentation from the private utility owner. The request for locates shall be a minimum of seventy-two (72) prior to proceeding with any excavation. If, after such requests, private utilities are encountered and damaged by the Contractor, these utilities shall be repaired at no cost to the City. If the Contractor damages staked or located private utilities, they shall be repaired by the utility owner and all costs of such repair shall be paid by the Contractor. Only written all clears will be acceptable, verbal all clears will not be accepted.

11.2 DEMOLITION

A. Pavement, Slabs, and Miscellaneous Concrete Items:
   1. Remove concrete slabs-on-grade, curbs, and miscellaneous concrete items as directed. Where concrete to be removed abuts concrete to remain, pavement shall be uniformly saw-cut along an existing joint. Jagged or crooked edges will not be acceptable. Concrete shall be broken up, hauled, and disposed of off-site.
   2. Remove asphalt paved roads, parking lots, walks, curbs, and miscellaneous asphalt as indicated on Contract Drawings. Cuts between pavement to be removed and pavement to remain shall be saw-cut to full depth, straight, smooth, and clean with no jagged edges. Asphalt shall be broken up, hauled, and disposed of off-site.
   3. Remove concrete pipe sections and miscellaneous concrete items as directed.
      a. Where concrete pipe is to be removed, it shall be uniformly saw-cut along an existing joint or disassembled at the joints. Jagged or crooked edges will not be acceptable. Concrete shall be broken up, hauled, and disposed of off-site.
      b. When Asbestos Concrete Pipe (ACP) is determined or suspected to be present the Contractor will need to hand dig the pipe sections to be removed. Any ACP sections will need to remain intact. The use of mechanical trenching equipment within eighteen inches (18") of any known or suspected ACP will not be permitted. Once the section that is to be removed has been excavated, an abatement Contractor will remove the sections of the pipe that are to be replaced or removed and the pipe shall be flush cut. The Contractor is responsible for notifying the Project Manager of any ACP that needs to be removed forty-eight (48)-hours prior to excavation of the area. If ACP is excavated that has not been previously identified the Contractor is responsible to contact the Project Manager either verbally or by email immediately upon discovery. Any ACP that is discovered to be damaged must be immediately reported to the Project Manager. The Project Manager will then notify the Abatement Contractor of the work that needs to be performed. The Abatement Contractor has twenty-four (24)-hours to respond and remove the ACP section(s).

   4. Remove road base material that is exposed after removing the pavement. This material shall be hauled and disposed of off-site unless otherwise directed by the Project Manager.

B. Abandoned Utilities: Remove aboveground utilities and terminate as approved by the utility company and the Project Manager. Remove necessary portions of underground utilities to a minimum of twenty-four inches (24") below the elevation of excavation or final grade. Cap off conduits with minimum twenty-four inch (24") long concrete plugs.

11.3 RESTORATION

A. Backfilling: Ensure that areas to be filled are free of standing water, frost, frozen material, vegetation, including roots and debris. Place fill materials in accordance with Division 31 Section "Earth Moving".

B. Grading:
   1. Restored Areas: Grade surface to blend with original contours and provide free drainage flow. All ruts and depressions where any amount of standing water collets shall be re-graded to a smooth natural appearance to ensure positive drainage.
   2. New Construction Areas: Grade as indicated in Division 31 Section "Earth Moving".

11.4 DISPOSAL

A. Remove trash, debris and waste materials, haul and legally dispose of it off the property. DADS disposal tickets and/or soil manifests shall be provided to the Contractor by the Project Manager.

B. The Contractor shall recycle materials, including but not limited to asphalt, concrete, metals, plastics. Recyclable materials shall be approved by the Project Manager and hauled to nearest recycling center and any non-recyclable materials shall be hauled to DADS.

C. Salvaged Material: All salvaged material remains the property of the City. Store or deliver as directed by the Project Manager.

11.5 FIELD QUALITY CONTROL

A. Comply with safety requirements for demolition, ANSI A10.6-83.

PART 12 - MEASUREMENT AND PAYMENT

12.1 MEASUREMENT **[Consultant to select A or B]**

A. Measurement will be based on the percentage complete for the lump sum contract amount for Demolition.

B. Measurement will be made by the contract unit specified for Demolition. Measurement shall include the actual number of units of specified materials(s) removed or placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

12.2 PAYMENT

A. Payment will be made at the **[contract unit]** [**lump sum contract**] price, and shall include required materials, transportation, equipment, labor, excavation, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, <**Insert additional items**> as required in accordance with the Contract Drawings and Specifications. The price shall include sawing or otherwise effectively cutting the existing paving, curb and gutter or concrete pipe smoothly and squarely in a manner satisfactory to the Project Manager. The price shall include the removal and offsite disposal of all materials including any base course deemed unsuitable by the Project Manager. No payment will be made for the removal and/or replacement of any paving, curb and gutter or pipe sections damaged by the Contractor beyond the authorized limits of removal.

END OF SECTION 02 41 00

SECTION 31 11 00 CLEARING AND GRUBBING

PART 13 - GENERAL

13.1 RELATED DOCUMENTS

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Report Documentation
1. City and County of Denver - Regulated Asbestos Contaminated Soil Standard Operating Procedure (RACS SOP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, May 2, 2019 (see Appendix).
2. City and County of Denver – Guidance for Reuse of Soil on City Projects, Denver Department of Environmental Health – Environmental Quality Division, October 5, 2017 (see Appendix).
3. **[City and County of Denver – Standard Materials Management Plan (MMP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, November 13, 2019 (see Appendix).]**
4. **[List geotechnical, investigative trenching, MMP, PSRMP or related documentation including dates, authorship, etc. (see Appendix).]**

13.2 SUMMARY

A. This Section includes requirements for stripping sod, and removing and disposing of vegetation and debris.

B. Related Sections:
1. Division 01 Section “Tree Retention and Protection”.
2. Division 01 Section “Erosion and Sedimentation Control”.
3. Division 02 Section “Demolition”.
4. Division 32 Section “Native Seeding”.

13.3 DEFINITIONS

A. Clearing and Grubbing: Refers to removing all surface objects and protruding objects not designated to remain shall be cleared and grubbed. This shall include but is not limited to trees, brush, stumps, logs, grass, weeds, roots, decayed vegetable matter, poles, stubs, rubbish, refuse dumps, sawdust piles, and loose boulders of one cubic yard (1 yd^3) or less existing outside of the construction limits, debris resting on or protruding through the ground surface, or appearing on the construction limits before final acceptance of the work. Clearing also includes removing and disposing of obstructions, such as fences, bridges, buildings, and other incidental structures within the construction limits and shown on the Site Demolition Plans.

B. **[Decompaction Area: Areas within the work limits, or as defined on Contract Drawings or by the Project Manager, that have vegetation that is sparse, stunted, anemic, weedy or was used as construction staging, a parking area, and/or subjected to heavy use.]**

C. **[Other Areas of Disturbed Topsoil: Areas disturbed, which may include clear and grub but not grading or other minor compaction, as determined by the Project Manager.]**

D. **[Plant-Protection Area: Area surrounding shrub beds, massing's, or other vegetation or sensitive areas to be protected during construction and indicated on Contract Drawings.]**

E. Sod Stripping: Shall be used when the vegetative material to be removed is mow able and generally less than twelve inches (12") tall.

F. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

G. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow, and ; reasonably free of subsoil, clay lumps, gravel, and other objects more than two-inches (2") in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

H. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, see Division 01 Section "Tree Retention and Protection".

I. Tree Removal: Refers to any individual woody plant with a height greater than overall width. Tree removal shall be performed by a Licensed and Insured Arborist licensed through the Office of the City Forester per Chapter 57 of the City and County of Denver Municipal Code.

J. **[Turf Conversion: Areas of existing turfgrass to be converted to another vegetation type.]**

K. **[Undisturbed Native Area: As designated on the Contract Drawings, Undisturbed Native Areas that are or were supporting healthy plant growth.]**

L. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

13.4 SUBMITTALS

A. Existing Conditions: Documentation of existing conditions, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
   1. Use sufficiently detailed digital photographs or videos.
   2. Include plans and notations to indicate specific damaged conditions of existing construction, site elements, and landscape.

B. Tree Removal Permit: The contractor shall obtain a removal permit request form available at Denvergov.org/Forestry, and submit the completed form to the Office of the City Forester and the Project Manager.

13.5 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Project Manager.

2. Provide alternate routes around closed or obstructed traffic ways if required by the Project Manager.

B. Improvements on Adjoining Property: Not allowed without prior approval from the Project Manager. Work only within Work Limit Line as defined on drawings.

C. Salvable Items: Carefully remove items indicated to be salvaged and store on City property where indicated.

D. Protection and Repair of Underground lines:
1. Existing Public Utilities: The Contractor shall have existing underground utilities located within the limits of work per General Contract Conditions, Article 804 Protection of Municipal, Public Service or Public Utility Systems. Request utility locates seventy-two (72) hours in advance of any excavations by calling the Utility Notification Center of Colorado at 811. The Contractor is responsible for providing written and graphical documentation from the utility owner. The Contractor shall take whatever precautions are necessary, including potholing, to verify location and depth to protect these underground lines from damage. Should unmarked or incorrectly marked utilities or other piping be encountered during excavation, notify the Project Manager immediately for direction. If damage does occur, all damage shall be repaired by the utility owner and all costs of such repair shall be paid by the Contractor. Only written all clears will be acceptable, verbal all clears will not be accepted.
2. Existing Private Utilities: The Contractor shall have existing underground utilities located within the limits of work per General Contract Conditions, Article 804 Protection of Municipal, Public Service or Public Utility Systems. The Contractor is required to contact all private utility companies, including The City and County of Denver departments, to locate all private utilities. The Contractor is responsible for providing written and graphical documentation from the private utility owner. The request for locates shall be a minimum of seventy-two (72) prior to proceeding with any excavation. If, after such requests, private utilities are encountered and damaged by the Contractor, these utilities shall be repaired at no cost to the City. If the Contractor damages staked or located private utilities, they shall be repaired by the utility owner and all costs of such repair shall be paid by the Contractor. Only written all clears will be acceptable, verbal all clears will not be accepted.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and tree and or plant protection measures are in place.

13.6 DELIVERY STORAGE AND HANDLING

A. All materials except for stripped topsoil and materials indicated to remain or to be stockpiled, shall remain the property of the City. All other materials shall be removed at the Contractor's expense.

PART 14 - PRODUCTS (Not Used)

PART 15 - EXECUTION

15.1 PROTECTION

A. The Contractor shall protect existing site conditions from damage during construction.
   1. The Contractor shall restore existing or protected conditions damaged by the Contractor during the Work of this Contract to its original condition, as acceptable by the Project Manager.

15.2 TRANSPLANTING

A. See Division 32 Section “Tree Transplanting”.

15.3 CLEARING

A. Remove brush and vegetation from areas designated to be cleared. As directed by the Project Manager and the Office of the City Forester, trim low hanging, unsound, or unsightly branches on existing trees and shrubs designated to remain. All cuts shall be in accordance with the Office of the City Forester’s standards and specifications.

15.4 GRUBBING

A. Remove all stumps, roots, and debris a minimum of twelve-inches (12”) below finish grade in all areas as required. Use hand methods for grubbing inside the tree protection zone of trees to remain. Backfill and compact stump and root holes to a maximum of eighty-five percent (85%) in landscape areas and ninety-five percent (95%) under hardscape or as directed by the Project Manager and the Office of the City Forester.

15.5 TOPSOIL STRIPPING

A. See Division 31 Section “Earth Moving”.

15.6 TURFGRASS REMOVAL

A. Outside of Tree Protection Zones existing turfgrass may be stripped to a depth of one-inch (1”) for the purposes of any hardscape or structural elements to ensure no organic matter remains. In areas where a vegetative cover will be installed the turfgrass may be tilled per Division 32 Soil Preparation.

B. Inside of Tree protection Zones existing turfgrass shall be eradicated using the methods called out in Division 32 Soil Preparation.

15.7 TREE REMOVAL

A. In all proposed landscaped areas, stumps and surface roots shall be ground to a minimum of twelve-inches (12") below finish grade. In proposed hardscape areas, all roots shall be removed entirely.

15.8 DISEASED TREE REMOVAL AND DISPOSAL

A. The removal of diseased and infested trees includes the requirement of offsite burial of all parts of the trees immediately following removal. This includes logs, stumps, roots, branches and composted and un-composted chips. Under no circumstances should diseased or infected wood be left or taken for firewood, mulch or taken to a wood processing mill.

15.9 DISPOSAL

A. Haul and dispose of all removed materials, trash, debris and waste materials legally inside and outside of the City's property. All recyclable materials shall be hauled to nearest recycling center and any non-recyclable materials shall be hauled to Denver Arapahoe Disposal Site (DADS). DADS tickets and/or soils manifests shall be provided to the Contractor by the Project Manager.

PART 1 - MEASUREMENT AND PAYMENT

1.1 MEASUREMENT **[Consultant to select A or B]**

A. Measurement will be based on the percentage complete for the lump sum contract amount for Clearing and Grubbing.

B. Measurement will be made by the contract unit specified for Clearing and Grubbing. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

1.2 PAYMENT

A. Payment will be made at the **[contract unit**] [**lump sum contract**] price, and shall include required materials, transportation, equipment, labor. The lump sum price shall include all clearing and grubbing of miscellaneous debris or items defined in Part 1 - General, including all other work necessary to ensure a clear dirt surface remains on the site. Price shall include the removal and offsite disposal of all materials. All recyclable materials shall be hauled to the nearest recycling center and any non-recyclable materials shall be hauled to DADS. DADS disposal tickets and/or soils manifests shall be provided to the Contractor by the Project Manager. No payment will be made for the removal of any brush and vegetation damaged by the Contractor beyond the authorized limits of removal.

END OF SECTION 31 11 00

Comment to all DPR Standard Specification Sections:
- Bold text and brackets [ ] are included in each specification section and to be edited per the project.
- If a bracketed item is not used for the project, delete.
- If a bracketed item is used in the project, remove front and end brackets and unbold the text.

SECTION 32 13 13 CONCRETE WALKS, CURBS, AND MISCELLANEOUS FLATWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Report Documentation
1. City and County of Denver - Regulated Asbestos Contaminated Soil Standard Operating Procedure (RACS SOP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, May 2, 2019 (see Appendix).
2. City and County of Denver – Guidance for Reuse of Soil on City Projects, Denver Department of Environmental Health – Environmental Quality Division, October 5, 2017 (see Appendix).
3. **[City and County of Denver – Standard Materials Management Plan (MMP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, November 13, 2019 (see Appendix).]**
4. **[List geotechnical, investigative trenching, MMP, PSRMP or related documentation including dates, authorship, etc. (see Appendix).]**

1.2 SUMMARY

A. This Section includes requirements for furnishing, placing, shoring, bracing, and anchorage of formwork, concrete reinforcement, accessories, and placing concrete flatwork, including walks, curbs and gutters, ramps, and pans, including installation of control and expansion joints, concrete curing and concrete finishing.

B. Related Sections:
1. Division 01 Section “Layout of Work and Surveys”.
2. Division 01 Section “Submittals”.
3. Division 01 Section “Contractor Quality Control”.
4. Division 01 Section “Tree Retention and Protection”.
5. Division 01 Section “Erosion and Sedimentation Control”.
6. Division 03 Section “Cast-In-Place Concrete”.
7. Division 11 Section “Playground Equipment and Structures”.
8. Division 31 Section “Earth Moving”.
9. Division 32 Section “Aggregate Base Course”.
10. Division 32 Section “Asphalt Pavement”.
11. Division 32 Section “Crushed Stone Paving”.
12. Division 32 Section “Pavement Markings”.
13. Division 32 Section “Playground Protective Surfacing”.
14. Division 32 Section “Chain Link Fencing”.
15. Division 32 Section “Irrigation Systems”.
16. Division 32 Section “Automatic Irrigation Controllers”.
17. Division 32 Section “Soil Preparation”.
18. Division 32 Section “Native Seeding”.
19. Division 32 Section “Sodding”.

1.3 REFERENCES

A. Note: All references below shall be from the most current edition.

B. American Concrete Institute (ACI):
   1. ACI 117 - Standard Tolerances for Concrete Construction and Materials.
   2. ACI 301 - Specifications of Structural Concrete for Buildings.
   3. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
   4. ACI 305 and 306 - Hot and Cold Weather Protection for Concrete.
   5. ACI 315 - Details and Detailing of Concrete Reinforcement.
   6. ACI 318 - Building Code Requirements for Reinforced Concrete.
   7. ACI 347 - Recommended Practice for Concrete Formwork.

C. American Society for Testing and Materials (ASTM):
   1. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement.
   2. ASTM C33 - Concrete Aggregates.
   3. ASTM C94 - Ready-Mixed Concrete.
   4. ASTM C595 - Portland Cement.
   5. ASTM C260 - Air Entraining Admixtures for Concrete.
   6. ASTM C494 - Water Reducing Admixtures for Concrete.
   7. ASTM C618 - Fly Ash Mineral Admixture for Concrete.
   8. ASTM C672 - Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.
   9. ASTM-C800 - Curing Compound, Concrete, for New and Existing Surfaces.
   10. ASTM C1059 - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
   11. ASTM-C1315 - Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete

D. Concrete Reinforcing Steel Institute (CRSI) - Manual of Standard Practice.

E. Colorado Department of Transportation (CDOT) - Standard Specifications for Road and Bridge Construction.

F. National Ready Mixed Concrete Association (NRMCA).

G. United States Department of Justice - Americans with Disabilities Act (ADA) Standards for Accessible Design, latest edition.

1.4 QUALITY CONTROL

A. Pre-Construction Conference: Conduct conference at location approved by the Project Manager.
   1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with concrete to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Concrete subcontractor.
      e. Special concrete finish subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semi-rigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, concrete repair procedures, and concrete protection.

1.5 SUBMITTALS

A. Qualification Data: Installer to document for Owner's Representative experience on projects of similar scope and scale successfully completed within the past five (5) years.

B. Product Data and Material Certificates: For each type of product and material indicated on the plans and in this specification.

C. Mix Designs:
1. Submit substantiating data for each concrete mix design specified for use to the Project Manager not less than four (4) weeks prior to first concrete placement. Concrete mix design data sheet shall not be more than one (1) year old from the submittal date. Data for each mix shall, as a minimum, include the following per section 2.7.B:
   a. Mix identification designation (unique for each mix submitted).
   b. Statement of intended use for mix.
   c. Mix proportions.
   d. Aggregates.
   e. Admixtures (must be approved by the Project Manager)
   f. Wet and dry unit weight.
   g. Entrained air content.
   h. Design slump.
   i. Strength qualification data.

D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

E. Compaction Test Reports from a qualified testing agency indicating compliance with requirements.

F. Strength Test Reports from a qualified testing agency indicating compliance with requirements.

G. Field quality-control reports.

1.6 DELIVERY, STORAGE AND HANDLING

A. General: Materials handling and batching shall conform to applicable provisions of ASTM C94.

B. Reinforcing: Unload and store reinforcing bars so they are kept free of mud and damage.

C. Project-Site Mixing: Not allowed without prior approval from the Project Manager. If allowed, submit process description to the Project Manager for approval prior to construction.

D. Hauling Time for Concrete: Deliver and discharge all concrete transmitted in a truck mixer, agitator, or other transportation device not later than one and one-half (1-1/2) hours from batch time, or three hundred (300) revolutions of the drum after the initial mixing water has been added, whichever is earliest.

E. Extra Water:
1. Deliver concrete to site in exact quantities required by design mix.
2. Should extra water be required for workability before depositing concrete, and the water/cement ratio of accepted mix design will not be exceeded, the General Contractor's Superintendent shall have the sole authority to authorize addition of water. Additional water shall not exceed one (1) gallon/cu. yd. Any additional water added to mix after leaving batch plant shall be indicated on truck ticket and signed by person responsible.
3. Where extra water is added to concrete, it shall be mixed thoroughly for thirty (30) revolutions of drum before depositing.
4. Water may be added at the site only once for each batch.
5. A full set of tests shall be performed after addition of water. Excessive slump or other out of range tests will be cause for rejection.

1.7 PROJECT CONDITIONS

A. Environmental Requirements:
1. Cold Weather Placement:
   a. If the daily temperature drops below forty degrees (40°) F for three (3) days prior to concrete placement or the temperature is expected to drop below forty degrees (40°) F on the day of the concrete placement, then comply with ACI 306R for preparation, protection, and curing of concrete.
   b. The mixed concrete temperature shall be between 50 and 90 ºF at the time of placement. Water, aggregates, or both shall be heated, when necessary, under such control and in sufficient quantities to avoid fluctuations in the temperature of the concrete of more than 10 ºF from batch to batch.
   c. If approved by the Project Manager, an accelerating admixture may be used. Admixtures shall meet requirements of Part 2. Calcium Chloride and other chloride-type accelerating admixtures are not allowed.
2. Hot Weather Placement:
   a. When placing concrete in hot weather, follow recommendations of ACI 305R.
   b. Placing of concrete during hot weather shall be limited by the temperature of the concrete at the time of placing. Mixed concrete which has a temperature of 90 ºF or higher, shall not be placed.
   c. When air temperatures on day of placement are expected to exceed ninety degrees (90°) F, mix ingredients shall be cooled before mixing. Flake ice or well-crushed ice of a size that will melt completely during mixing may be substituted for all or part of mix water.
   d. If approved by the Project Manager, a retarding admixture may be used. Admixtures shall meet requirements of Part 2.

1.8 RIGHT OF WAY WORK

A. Contractor shall obtain all necessary permits when working with in the Right of Way.

B. Contractor shall preserve and protect all permanent land survey control markers. Per the General Contract Conditions Article 319 “Preservation of Permanent land Survey Control Markers”.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Hand Placed Steel Forms: Hand placed steel forms are only to be used for sections that are straight and have no bend, radii or curvature in the sections to be used.

B. Wood Forms: Forms shall be made of solid one side grade, sound, undamaged lumber with straight edges.
1. Curved elements (bends, radii, or curvature) shown on plans are to be constructed with smooth-curved plywood forms a minimum of one-half inch (1/2”) think. Faceted forms composed of straight sections will not be accepted.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

2.2 [STEEL REINFORCEMENT]

A. **[Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of pre-consumer recycled content is not less than twenty five percent (25%).]**

B. **[Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.]**

C. **[Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.]**
1. **[Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.]**

D. **[Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars. Cut bars true to length with ends square and free of burrs.]**

E. **[Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars.]**

F. **[Tie Wire: ASTM A1064, minimum sixteen (16) gauge annealed type.]**

G. **[Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.]**

H. **[Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, and dowels in place. Manufacture bar supports according to**

CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:]

1. **[Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.]**
2. **[For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.]**

2.3 CONCRETE MATERIALS

A. Provide materials in accordance with ACI 301, unless amended or superseded by requirements of this section or general notes on structural drawings.
   1. General: Ready-mixed Concrete: ASTM C94. On-site mixed concrete not allowed.
   2. Cement: ASTM C595. Type 1L.
   3. Fly Ash: ASTM C618 Class F.
   4. Aggregate: ASTM C33.
      a. All sand and aggregates to meet C-33 Table 3 for Class 4S "Severe Weathering Region".
         1) Fine Aggregate: Clean, natural sand.
         2) Coarse Aggregate: Clean gravel or crushed stone.
   5. Water: ASTM C 94/C 94M, clean and not detrimental to concrete.

2.4 ADMIXTURES

A. General: Unless specified, no admixtures may be used without specific approval of the Project Manager.

B. Prohibited Products: Calcium chloride or admixtures containing more than 0.05% chloride ions or thiocyanates are not permitted.

C. **[Color Admixture: Color Pigment: ASTM C 979, synthetic mineral-oxide pigments, or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.]**
   1. **[Manufacturers: Subject to compliance with requirements, provide products by one of the following:]**
      a. [Davis Colors.]
      b. [Dayton Superior Corporation.]
      c. [Scofield, L.M. Company.]
      d. [Consultant to specify manufacturer.]

   2. **[Color: Match Architect's sample.]**

D. Air-Entraining Admixture: ASTM C260.

E. Water Reducing Admixture: ASTM C494, Type A.

F. High Range Water Reducing Admixture (Superplasticizer): ASTM C494, Type F or G.

G. Warm weather admixtures: ASTM C494. Use of admixtures will not relax warm weather placement requirements.

H. Cold Weather Admixtures: ASTM C494. Use of admixtures will not relax cold weather placement requirements.

2.5 CONCRETE MIX

A. Refer to the Denver Right of Way Services approved materials list of pre-approved concrete mixes at the following website:
   1. https://www.denvergov.org/content/denvergov/en/transportation-infrastructure/programs-services/right-of-way-services/street-occupancy.html

B. All Concrete mixes from the approved list or submitted for approval shall meet the following criteria.
   1. Mix concrete in accordance with ASTM C94 and ACI 301 Chapter 3.
   2. Cement Content: Type 1L cement, minimum of five hundred twenty-eight (528) pounds per cubic yard.
   3. Fly Ash: Class F per CDOT Standard Specifications for Road and Bridge Construction Section 701.02. Fly ash shall be a minimum of twenty percent (20%) and not exceed twenty-five percent (25%) of total cementitious material by weight unless approved by the Project Manager.
   4. Maximum water-cement ratio: 0.45.
   5. Slump: Four inches (4") maximum when hand placed.
   6. Air Entrainment: five percent (5%) to eight percent (8%).
   7. Aggregate Size: three-quarter inch (3/4") maximum.
   8. Shall be four thousand five hundred pounds per square inch (4,500 PSI).
   9. Concrete for Exterior Flatwork, including Pavement, Curb and Gutter, and Drainage Pans shall be Class B, Class D, and Class P, or as approved by the Project Manager.

2.6 FIBROUS CONCRETE REINFORCEMENT

A. Shall be one hundred percent (100%) virgin polypropylene, fibrillated fibers containing no reprocessed olefin materials and specifically manufactured to an optimum gradation utilizing twenty-five (25) individual fiber designs for use as concrete secondary reinforcement. Volume per cubic yard shall be one and one-half (1.5) pounds, or in accordance with manufacturer's recommendations. Fiber manufacturer must document evidence of five (5) year satisfactory performance history, compliance with applicable building codes and ASTM C1116 Type III 4.1.3 and ASTM C1116 Performance Level I.
   1. Fibrous concrete reinforcement shall be utilized in all flatwork applications.

2.7 EXPANSION JOINT MATERIAL

A. Interior Use or Exterior Use where sealants are specified: Bituminous saturated fiber conforming to ASTM D1751, three-eighths inch (3/8") thick. Provide manufacturer's certification of compatibility with specified sealants where required.

B. Pre-molded closed cell polyethylene foam backer rod if required.

C. Joint Sealant: ASTM D 5893 Type NS, silicone per CDOT's approved joint and crack sealant list. Where concrete color additive is used, sealant color to match adjacent concrete.

2.8 SLIP JOINTS

A. Speed Dowel Model PSD09/#4TX, 9" long sleeve to accommodate 18" smooth steel round bar, 5/8" diameter. Manufactured by Sika/Greenstreak, or approved equal.

2.9 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately nine (9) oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Spray Curing and Sealing Compound: VOC compliant, acrylic polymer, water-based or meets the solvent based restrictions, ASTM C 1315, Type I (clear), Class B, non-yellowing.
1. Products: [**provide the following**]
   a. [Product.]
   b. [Or approved equal.]

2.10 RELATED MATERIALS

A. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of one eighth-inch (1/8") to one quarter-inch (1/4") to match the Project Manager's sample.
1. Products: [**provide the following**]
   a. [Product.]
   b. [Or approved equal.]

2.11 [CONCRETE COLOR HARDENER]

A. **[Dry-shake, colored surface hardener, streak free, non-fading surface with synthetic iron oxide pigments meeting ASTM C979. Increase to abrasion resistance and surface density.]**
1. Products: [**provide the following**]
   a. [Product.]
      1) [Color:]
   b. **[Or approved equal.]**

2.12 TRUNCATED DOME INSERTS FOR RAMPS

A. All truncated domes within Parks maintained areas shall be unpainted grey cast iron plates conforming ASTM A-48 class 30.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Requirements of Regulatory Agencies: Comply with all applicable provisions of the state and local building and safety codes.

B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer, unless otherwise approved by Project Manager.

C. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

D. Testing: All testing shall be completed by the Contractor at their expense unless otherwise specified by the contract.

E. Testing Agency Qualifications: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures. Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

F. Testing Frequency: Obtain at least one composite sample for each one hundred (100) cubic yards, or fraction thereof of each concrete mixture placed each day.
      a. When frequency of testing will provide fewer than five (5) compressive-strength tests for each concrete mixture, testing shall be conducted from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used.
   2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one (1) test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   4. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one (1) set of four (4) standard cylinder specimens for each composite sample.
   5. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at twenty-eight (28) days and keep one for backup in the event a sample should break.
      a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at twenty-eight (28) days.

G. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than two-hundred (200) psi.

H. Test results shall be reported in writing to the Project Manager, concrete manufacturer, and Contractor within forty eight (48) hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at twenty eight (28) days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both seven (7) and twenty eight (28) day tests.

I. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Project Manager.

J. Concrete work will be considered defective if it does not pass tests and inspections.

K. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

L. Prepare test and inspection reports.

M. Record of Work: A record shall be kept by the Contractor listing the time and date of placement of all concrete for the structure. Such record shall be kept until the completion of the project and shall be available to the Project Manager for examination at any time.

N. Mockups: Prior to starting any concrete work, provide a sample panel using materials indicated for project work. For each type, color and finish of concrete specified, build panel at the site of full thickness and approximately ten feet (10') by 10 feet (10'), including expansion joints, control joints, scales, fillers, and one radial edge. Provide the workmanship proposed for the work. Correct and replace sample panel until the Project Manager's acceptance of the Work. Retain panel(s) during construction as a standard for completed paving work.
   1. Build panel approximately one hundred (100) sq. ft. in the location indicated or, if not indicated, as directed by the Project Manager.
   2. Approved mockups may become part of the completed Work if approved prior to the construction of the mockup and is undisturbed at time of Substantial Completion.
   3. Notify the Project Manager a minimum of seven (7) days in advance of dates and times when mockups will be constructed.
   4. Obtain the Project Manager's written approval of the mockups before starting construction.
   5. If the Project Manager determines that the mockup does not meet the requirements, demolish, and remove from the site and cast another until the mockup is approved.
   6. Maintain the mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   7. Demolish and remove mockups when directed by the Project Manager.

O. Tolerances: Comply with tolerances in ACI 117, the Contract Drawings, and as follows:
   1. Elevation and Cross-slope: In conformance with grading plans and Americans with Disabilities Act (ADA).
   2. Thickness: Plus, three-eighths inch (3/8"), minus one-quarter inch (1/4").
   3. Surface: Gap below ten feet (10') long, unleveled straightedge not to exceed one-eighth inch (1/8").
   4. Lateral Alignment and Spacing of Dowels: one inch (1").
   5. Vertical Alignment of Dowels: one-quarter inch (1/4").
   6. Joint Spacing: three inches (3").
   7. Contraction Joint Depth: Plus, one-quarter inch (1/4"), no minus.
   8. Joint Width: Plus, one-eighth inch (1/8"), no minus.

3.2 PREPARATION OF SUBGRADE

A. Excavate to required depth in accordance with geotechnical report. Remove soft, yielding material and replace with select fill. Compact to minimum ninety-five percent (95%) Standard Proctor within two percent (2%) of optimum moisture.

B. Refer to Division 31 Section: Earth Moving for requirements for subgrade testing and proof-rolling.

C. Maintain subgrade in a compacted condition until concrete is placed.

D. If existing irrigation is not modified per the Contract Documents, the Contractor shall work with the Project Manager and Park Operations to identify locations and size for irrigation sleeves for future use to be installed under the form work prior to concrete installation. Refer to Division 32 “Irrigation Systems”.

3.3 FORMS

A. Metal, plastic, or uniform warp free lumber forms, coated with form release agent. Slope forms to give slabs positive drainage and stake securely. Obtain approval of the Project Manager for alignment and grade of forms a minimum of forty-eight (48) hours prior to placing concrete. Any concrete work installed without obtaining approval from the Project Manager shall be subject to removal and replacement at the discretion of the Project Manager, at no cost to the City.

B. Radii shall be continuous and flowing to avoid angular intersections in the horizontal alignment, radial forming shall use bender board or approved equal as directed by the Project Manager.

3.4 REMOVING AND REUSING FORMS

A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

3.5 STEEL REINFORCEMENT

A. Install steel reinforcement only in locations shown on Contract Drawings.

B. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

C. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

D. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.6 CONCRETE PLACEMENT

A. Prior to placing any new sections of concrete pavement, the entire subgrade shall be scarified to a depth of 6-inches. In areas where existing pavement is to be removed and replaced the

existing compacted subgrade may be reused if the subgrade meets specified compaction. In areas of existing subgrade that do not meet the specified compaction, materials shall be removed, replaced and compacted to meet the specified proctor density. Adjust moisture content and compact as hereinafter specified.

B. Contractor's Review: The Contractor shall inspect forms and reinforcing prior to concrete placement to assure accurate placement embedded items and overall acceptability.

C. Project Manager's Review: Contractor shall provide minimum of forty-eight (48) hours' notice to the Project Manager to allow review of forms and reinforcement before concrete is placed and to observe placing of concrete.

D. Do not place concrete on frozen surfaces.

E. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

F. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

G. Do not add water to concrete during delivery.

H. Deposit and spread concrete in a continuous operation between transverse joints. Do not use vibratory equipment to move concrete into place.

I. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
   1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies**,** reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

J. Screed paving surface with a straightedge and strike off.

K. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

L. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

M. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
   1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

N. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
   1. When air temperature has fallen to or is expected to fall below forty degrees (40°) F, uniformly heat water and aggregates before mixing to obtain a concrete mixture

temperature of not less than fifty degrees (50°) F and not more than eighty degrees (80°) F at point of placement.

2. If subgrade is frozen, as determined by Geotechnical Engineer and/or Project Manager, thaw subgrade to depth of eight (8") prior to placing concrete.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

O. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below ninety degrees (90°) F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 CONCRETE FINISHING

A. Allow time for bleed water to appear, then scrape or push off all bleed water. Do not work water into surface.

B. Final level, light bull float, but do not trowel surface.

C. After darbying or bullfloating, stop finishing until bleeding has ceased and until concrete can support foot pressure with only about one eighth-inch (1/8") indentation. During or after the first floating, check planeness of surface with a ten foot (10') straightedge applied at not less than two different angles, and then cut down all high spots and fill all low spots to achieve a true plane within one eighth-inch (1/8") in ten feet (10').

D. Finishes:

1. Medium Broom Finish: Provide a medium broom finish for all exterior concrete unless otherwise noted. Immediately after float finishing and tool work, roughen surface with fiber-bristle broom to match the approved mockup panel. Confirm direction or pattern of broom finish with the Project Manager prior to commencing slab placement.
2. **[Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:]**
   - **a. [Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.]**
   - **b. [Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.]**
   - **c. [Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.]**
   - **d. [Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.]**
3. **[Seeded Exposed-Aggregate Finish:]**

a. [Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of one sixteenth inch (1/16").]

b. [Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.]

c. [Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.]

d. [Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half (1/2) of the diameter of the smallest aggregate.]

e. [Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.]

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a three eighths-inch (3/8") radius. Final concrete finish to completed following jointing. Surface/edging tool marks along the concrete edge are not acceptable. The final product shall have a clean edge.

F. Accessible Ramps:

1. Install per the Denver Department of Transportation and Infrastructure (DOTI) Transportation Standards and Details with cast iron truncated domes in any Denver Parks and Recreation maintained areas.

G. Do not use evaporative retarders as finishing aid.

3.8 CONCRETE CURING AND SURFACE TREATMENTS

A. General:

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Maintain concrete with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of concrete.
2. Curing shall commence as soon as free water has disappeared from the concrete surface after placing and finishing. The curing period shall be seven days for all concrete unless test cylinders, made and kept adjacent to the structure and cured by the same methods, are tested with the average compressive strength equal to seventy percent (70%) of the specified twenty-eight (28) day strength.
3. Curing shall be in accordance with ACI 301 procedures. Avoid rapid drying at the end of the curing period. During hot and cold weather, cure concrete in accordance with ACI 305R and ACI 306R.

B. Curing Methods: Perform curing of concrete by curing and sealing compound, by moisture curing, by moisture-retaining cover curing, or by combinations thereof, as herein specified. Coordinate with and choose a curing method that is compatible with the requirements for subsequent material usage on the concrete surface.

1. Provide curing and sealing compound to exterior slabs, walks, curbs, etcetera as follows:
   a. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete. Apply uniformly in continuous operation by

power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to rainfall within three hours after initial application.

b. Maintain continuity of coating and repair damage during period.

2. Provide moisture curing by one of the following methods:
   a. Keep concrete surface continuously wet by covering with water.
   b. Continuous water-fog spray.
   c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping it continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.
3. Provide moisture retaining cover curing as follows: Cover concrete surfaces with a moisture-retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least 3-inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

C. Curing Formed Surfaces: Where wooden forms are used, cure formed concrete surfaces by moist curing with forms in place for full curing period or until forms are removed. When forms are removed, continue curing by methods specified above for specified curing time.

D. **[Concrete Color Hardener: Refer to manufacturer's recommendations for placement of color hardener.]**

3.9 JOINT

A. Construct joints true to line with faces perpendicular to surface.

B. Expansion Joints: Expansion joint material shall be provided at the following locations and shall be in place prior to the placing of concrete:
1. As shown on the Contract Drawings; or
2. At each end of curb return.
3. Between sidewalk and driveway slabs or service walks.
4. Between new concrete and existing concrete.
5. Between new concrete and fixed vertical objects.
6. At a maximum of two hundred foot (200') spacing.
7. Provide a minimum of a three-eighths inch (3/8") and a maximum of a half-inch (1/2") thick by full depth of the slab material, allow half-inch (1/2") thickness at the top to be filled with joint sealer.
8. As directed by the Project Manager.
9. Thoroughly clean all surfaces prior to installation of sealant material.

C. Construction Joints: Construction joints shall be provided at the following locations:
1. As shown on the Contract Drawings; or
2. In locations where existing concrete is adjacent to new concrete where expansion joints are not required.
3. As directed in the field by the Project Manager.

D. Slip Joints:
1. To be used at all Expansion Joints and Construction Joints **except** at buildings, curbs, ramps, and stairs.

2. Dowels to be placed no closer than twelve-inches (12”) from edge of concrete and twenty-four-inches (24”) on-center.
3. Attach bases to the face of concrete forms using a double-headed nail or self-tapping screw.
4. Center of base shall be centered on form.
5. Prior to placing concrete, Speed Dowel sleeve shall be slipped over base.
6. Concrete shall not be placed directly over the Speed Dowel System. Place concrete minimum eighteen inches (18”) from Speed Dowel system and work concrete around the Speed Dowel System.
7. Concrete forms shall be removed with bases still attached. Bases may be reused.
8. Install slip dowels to the full depth of the embedded Speed Dowel sleeve and proceed with next concrete pour.
9. Greasing of dowels is not required. Embedded Speed Dowel Sleeve accommodates expansion and shrinkage movements that may occur.
10. Bent or badly sheared slip dowels shall not be used. Saw cut dowels recommended, deburr ends.
11. Place edge forms plumb. Out of plumb forms may result in misaligned dowels.

E. Contraction (Control) Joints in Walks: Contraction joints shall be formed with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut one eighth-inch (1/8”) wide joints into concrete that has hardened sufficiently that cutting action will not tear, abrade, or otherwise damage surface, but before development of random contraction cracks. Saw cut joints shall be spaced at a distance equal to the width of the walk, but not over ten feet (10’) unless approved by the Project Manager. Depth of joints shall be one-fourth (1/4) the slab thickness.
1. Tooled joints will not be allowed on concrete, unless directed by the Project Manager.
2. A contraction joint plan shall be reviewed and approved in the field with the Project Manager prior to cutting. If a joint plan is provided as part of the Contract Documents, confirm the plan with the Project Manager and gain approval prior to cutting.

F. Curb and Gutter Contraction (Control) Joints: Space curb and gutter joints not more than twelve foot six-inches (12’-6”) on center, and align them with sidewalk joints. Contraction joints shall be tooled. Form plane of weakness by inserting and later removing a metal divider, finish with an edger or groover, or by saw cutting a previously tooled joint.

3.10 FORM REMOVAL

A. Remove forms after concrete surface is hard enough so as not to be damaged in any way. Reasonable care is to be used in removing forms. Repair minor defects with high strength grout as per the Project Manager’s direction. Plastering will not be permitted on exposed faces.

3.11 CONCRETE EDGE TREATMENT AND BACKFILLING

A. Refer to Division 32 Section “Soil Preparation”.

3.12 RESTORATION

A. Refer to Division 32 Section “Sodding” and Division 32 Section “Native Seeding”.

3.13 CLEANING

A. Perform cleaning during installation of the Work and upon completion of the Work. Remove all excess materials, debris, and equipment from the site. Repair any damage resulting from installation of the concrete.

B. Sweep and wash paving not more than (2) two days prior to the date scheduled for Substantial Completion inspections.

3.14 PROTECTION AND REPAIR

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Project Manager.

B. Drill test cores, where directed by the Project Manager, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material.

3.15 ACCEPTANCE

A. Concrete work will be accepted when it meets the specified strength and all other requirements of this specification.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement will be made by the contract unit specified for Concrete Walks, Curbs and Miscellaneous Flatwork. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

A. Payment will be made at the **contract unit** price, and shall include required materials, transportation, equipment, labor, excavation, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, compaction, sub-grade preparation, formwork, placing of concrete, reinforcing, joints, curing, finishing, and all other items required to complete the work as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 13 13

PART 5 - GENERAL

5.1 RELATED DOCUMENTS

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Report Documentation
1. City and County of Denver - Regulated Asbestos Contaminated Soil Standard Operating Procedure (RACS SOP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, May 2, 2019 (see Appendix).
2. City and County of Denver – Guidance for Reuse of Soil on City Projects, Denver Department of Environmental Health – Environmental Quality Division, October 5, 2017 (see Appendix).
3. **[City and County of Denver – Standard Materials Management Plan (MMP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, November 13, 2019 (see Appendix).]**
4. **[List geotechnical, investigative trenching, MMP, PSRMP or related documentation including dates, authorship, etc. (see Appendix).]**

5.2 SUMMARY

A. This Section includes the requirements for the installation of an underground irrigation system including the following:
1. Trenching, stockpiling excavation materials, refilling and compacting trenches.
2. Complete irrigation system including but not limited to piping, valves, fittings, heads, wiring, sensors, backflow preventer(s), Automatic Irrigation Controller(s) and final adjustments to insure complete coverage.
3. Water connections.
4. Replacement of unsatisfactory materials.
5. Cleanup, inspections, and approval.
6. Testing.

B. Related Sections:
1. Division 01 Section “Erosion and Sedimentation Control”.
2. Division 01 Section “Tree Retention and Protection”.
3. Division 32 Section “Concrete Walks, Curbs, and Miscellaneous Flatwork”.
4. Division 32 Section “Native Seeding”.
5. Division 32 Section “Sodding”.

5.3 REFERENCES

A. Conform to requirements of reference information listed below except where more stringent requirements are shown or specified in Contract Documents.
1. American Society for Testing and Materials (ASTM) - Specifications and Test Methods specifically referenced in this Section.
2. Underwriters Laboratories (UL) - UL Wires and Cables.

3. National Sanitation Foundation (NSF) – Piping and backflow prevention.
4. American Water Works Association (AWWA) – Piping and backflow prevention.

5.4 QUALITY CONTROL

A. Special Requirements.
1. Tolerances: Specified depths of mains and laterals and pitch of pipes shall be installed per the Contract Drawings and specifications.
2. Compaction: Settlement of trenches is cause for removal of finish grade treatment, refilling, compaction, and repair of finish grade treatment.
3. Coordination with Other Contractors: Protect, maintain, and coordinate work with work under other Sections.
4. Damage to other Improvements: Contractor shall replace or repair damage to grading, soil preparation, seeding, sodding, planting and/or new site features done under other Sections during Work associated with installation of irrigation system at no additional cost to the City.
5. Damage or Disturbance to the Existing Irrigation Components: Damage to existing components as a result of work being performed by the Contractor will require the Contractor to replace the damaged components to the City's current standards, at no additional cost to the City.
6. Salvaged Parts: The Contractor is responsible for removal of all existing heads, valves and valve boxes being replaced as part of the Project. Equipment shall be returned to Denver Parks Operations and Maintenance staff.
7. Water Delivery Interruption: When working on an existing irrigation system, the Irrigation Contractor shall contact the Project Manager and inform them, seventy-two (72) hours in advance, of any water interruption that is required. The maximum irrigation system interruption is to be no more than seventy-two (72) hours during the growing season, without prior approval from the Project Manager. The Contractor shall make all necessary provisions including material, equipment, labor, delivery and scheduling as required to complete all points of connection, upgrades, and improvements within seventy-two (72) hours.
8. Watering: The Contractor is responsible for following all Denver Water rules and regulations for sod and seed establishment, available at http://www.denverwater.org. The Contractor shall post signs per Denver Water in a visible location(s) on site indicating "IRRIGATION TESTING AND MAINTENANCE IN PROGRESS" when Work (establishment, construction or warranty) requires irrigation system operation between the hours of 10 AM to 6 PM. The signs to be used are included within the Appendix.
9. Permits: Work involving high voltage electrical wiring, grounding and related Work shall be executed by licensed and bonded electrician. Secure a permit at least forty-eight (48) hours prior to start of installation

B. Pre-Construction Conferences and Site Meetings:
1. Contractor shall schedule and conduct a pre-construction conference to review in detail quality control and construction requirements for equipment and materials used to perform the Work. Conference shall be scheduled not less than ten (10) days prior to commencement of Work. All parties required to be in attendance shall be notified no later than seven (7) days prior to date of conference. Contractor shall notify qualified representatives of each party concerned with that portion of Work to attend conference, including but not limited to the Project Manager, Denver Parks District Manager, Operations Supervisor, the Contractor's Superintendent, and Installer.

2. Prior to commencement of Work, Contractor shall schedule an on-site conference with Project Manager, Office of the City Forester and any other parties designated by Project Manager to discuss tree protection requirements, staging locations, traffic control, and equipment access. Provide a minimum of seven (7) days' notice prior to date of conference.
    a. Identify on Contact Drawings all locations of existing components.
    b. Verify the operation of each component.
    c. Provide documentation of existing components and conditions to the Project Manager prior to starting Work.
3. Contractor shall schedule on-site conferences the frequency of which is to be determined by the Project Manager and any other parties designated by the Project Manager to review project progress.
4. Contractor shall record Meeting Minutes of each conference and distribute to all parties in attendance within three (3) days of conference.

5.5 SUBMITTALS

A. Prepare and make submittals in accordance with conditions of the Contract prior to installation of any irrigation equipment:

B. Material List: Submit a PDF file of complete list of materials, and cut sheets indicating manufacturer, model number and description of all materials and equipment to be used. Only include specific cut sheets for the products being used as part of the Project. Show appropriate dimensions and adequate detail to accurately portray intent of construction.

C. Shop Contract Drawings: If applicable, submit shop Contract Drawings for pumps, backflows and assemblies. Include plumbing and foundation/support systems if the installation differs from the manufacturer's recommended installation.

D. Mock-ups:
1. Valve assembly: Provide a completely built electrical valve assembly. This mock-up, to include electric valve, service tee, lateral valve riser, length as required for mainline depth, and male thread by spigot outlet adapter. The mock-up may be incorporated into the work toward the end of the project.
2. Swing joints: Provide a swing joint assembly for each detail shown (e.g. - quick coupler, rotors and pop-up spray head) or as directed by the Project Manager
3. Drain valves: Provide a mock-up including the service tee, required fittings, and drain valve.
4. Other: Mock-ups that may be requested by the Project Manager.

E. Operation and Maintenance Manual: Supply Operation and Maintenance information for installed booster pumps and pump stations. See Division 01 Section "Operation and Maintenance Data" for manual requirements.

F. Warranty: Submit a written Warranty, in accordance with WARRANTY/GUARANTEE section.

5.6 CONTRACT RECORD DRAWINGS

A. Prior to the installation of the irrigation system, the Contractor will provide on-site copies of the original irrigation design Contract Drawings for "Contract Record Drawings". Contractor to revise Contract Record Drawings in red ink as the Work progresses to show any changes to the plan and include field dimensions. Contract Record Drawings shall be brought up-to-date prior to any Pay Application Submittals that contain irrigation installation. Should the Contractor choose to utilize GPS for the purposes of documenting Work in progress, a hard copy print will need to be provided prior to Pay Application Submittal. A print of Contract Record Drawings shall be available at Project Site for review by the Project Manager at any time during the project.

B. Contract Record Drawings shall be completed by an Irrigation Consultant or qualified draftsperson. Encompass entire Scope of Work including any altered existing equipment and altered zones. Note the Automatic Irrigation Controller zone number, type of irrigation equipment, gallons per minute (GPM) and operating pressure (PSI) for any altered or added zone.

C. Preparation of Contract Record Drawings: Dimension from two (2) permanent points of reference (building corners, sidewalk corners/intersections, road intersections, permanent structures, light poles, or utility cabinets) the location of the following items:

1. Point of connection
2. Meters and Vaults
3. Curb stops
4. Drain valves
5. Pumps
6. Backflows
7. Bypass lines
8. Service lines
9. Routing of irrigation mainline. Provide dimensions for each change of direction and every two hundred linear feet (200 L.F.) maximum along each run
10. Routing of non-pressure lateral lines, layout and size, if altered from original design
11. Zone control valves
12. Quick coupling valves
13. Flow meter
14. Master valve
15. Rain sensors/rain gauges/weather stations
16. Wire splice boxes
17. Control wire routing, if not with pressure mainline
18. Gate valves
19. Air relief valves
20. Sleeves
21. Flush valves
22. Power service drop
23. Two-wire ground rods and plates
24. Other related equipment as directed

D. Make dimensions accurately at the same scale used in the original Contract Drawings, or larger. Notes and dimension lettering must be legible. Dimension lines shall be drawn on the plan(s) neatly along the outside edge and shall be red for clarity. Do not place dimension lines or

lettering on top of irrigation lines or heads. Scale shall be included on the drawings. PDF version to be black and white with red lines and text for dimensions.

E. The irrigation legend and zone call outs must be changed to accurately reflect the irrigation equipment installed, if such equipment is not the same as originally specified on the contract documents. This includes type of head, flow rates, effective spray diameter/radius and operating pressure of all sprinkler heads.

F. The Project Manager will not certify any pay request submitted by the Contractor if the Contract Record Drawings are not current, and processing of pay request will not occur until Contract Record Drawings are updated.

G. Prior to the Substantial Completion walk, the Contractor shall provide a digital copy of the irrigation design with record installation information that reflects all changes made over the course of the construction project. Contract Record Drawings shall include details of any revisions as per actual installation. Deliver and submit to the Project Manager for review of the following items:
   1. Digital Contract Record Drawings in both PDF and AutoCAD format (include any related X-ref files, plot files and pen settings.) Make any additional changes to the file as directed by the Project Manager prior to final submittal and approval.

H. Request for Substantial Completion will not be processed until all Contract Record Drawing prints and digital files have been received and approved by the Project Manager.

5.7 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver all components to job site in original unopened packaging containers prominently displaying manufacturer's name, volume, quantity, contents, instructions, and conformance to local, state, and federal law. Remove and replace cracked, broken, or contaminated items or elements prematurely exposed to moisture, inclement weather, snow, ice, temperature extremes, fire, or jobsite damage.

B. Handling, Storage and Delivery of PVC Pipe:
   1. Exercise care in handling, loading and storage of PVC pipe.
   2. All PVC pipe shall be transported in a vehicle which allows length of pipe to lie flat so as not to subject it to undue bending or concentrated external loads. All sections of pipe that have been dented or damaged shall be discarded, and shall be replaced with new piping.

C. Storage and Protection: Deliver, unload, store, and handle materials, packaging, and products in dry, weatherproof condition in manner to prevent damage, breakage, deterioration, intrusion, ignition, and vandalism.

D. Only materials and equipment meeting project specifications and to be used as part of Project shall be stored on site. Project Manager to may verify at any time during construction period.

5.8 JOBSITE CONDITIONS

A. Existing Conditions:
   1. Soil Conditions: The Contractor is responsible for investigating the type of soil and conditions in which lines are to be installed. No extra payment will be allowed due to difficulty in trenching, unless approved by the Project Manager.

2. Contractor is responsible for understanding the scope of related operations as specified and indicated in the Contract Drawings and Specifications before beginning Work under this Section.
3. Report unsatisfactory conditions in writing to the Project Manager within twenty-four (24) hours of discovery. Commencement of installation means acceptance of existing conditions by the Contractor.

B. Protection of Property:
1. Protect buildings, walks, walls, and other property from damage. Erect and maintain barricades, warning signs and lights, and provide guards as necessary or required to protect all persons on the site. Damage caused to asphalt, concrete, monuments, structures or other building material surfaces shall be repaired or replaced at no cost to the City. Restore all disturbed areas to original condition.
2. The Contractor is responsible for potholing of all existing utilities, irrigation lines or any other underground improvements that may be damaged due to the installation of Irrigation Systems.

C. Protection of Existing Trees:
1. Refer to Division 01 Section "Tree Retention and Protection".

D. Protection and Repair of Underground Lines:
1. Request utility locates seventy-two (72) hours in advance of any excavations by calling the Utility Notification Center of Colorado at 811. Take whatever precautions are necessary, including pot holing to verify location and depth to protect these underground lines from damage. If damage does occur, all damage shall be repaired by the Utility Owner. All costs of such repairs shall be paid by Contractor.
2. The Contractor is required to contact all private utility companies including Denver City Departments to locate all private utilities. The request for locates shall be a minimum of seventy two (72) hours prior to proceeding with any excavation. If, after such requests private utilities are encountered and damaged by the Contractor these shall be repaired at no cost to the City. If the Contractor damages staked or located private utilities, they shall be repaired by the Utility Owner at the Contractor's expense.

E. Replacement of Paving and Curbs: Any damage due to work that occurs adjacent to or crosses existing roadways, paths, trails, curbing, sidewalks, etc. shall be restored to original condition at the contractors expense, and the satisfaction of the Project Manager.

5.9 WARRANTY/GUARANTEE

A. Provide a one (1) year written warranty for material and installation from the date of Substantial Completion.

B. Expenses due to vandalism before Substantial Completion shall be the Contractor's responsibility.

C. Any settling of backfilled trenches that occurs during warranty period shall be repaired at no expense to the City, including complete restoration of damaged property.

D. The Contractor is responsible to monitor and coordinate Automatic Irrigation Controller scheduling and maintenance with the Project Manager for any seeding, sodding, or planting areas under the Contractor's warranty.

E. Project Manager reserves the right for Parks Operations Staff to make temporary repairs during the warranty period as necessary to keep systems in operating condition without voiding the Contractor's warranty, nor relieving the Contractor of their responsibilities.

F. The Contractor shall make repairs and replacements within three days of notification. If the Contractor fails to make repairs within three days, the City will make such repairs at the Contractor's expense.

5.10 TURN OVER ITEMS

A. Where applicable, furnish the following maintenance items to City prior to Substantial Completion:
   1. Two (2) sprinkler heads for each size and type specified.
   2. Two (2) nozzles for each type of head and spray pattern.
   3. Two (2) head adjustment tools for each type of head installed.
   4. Two (2) valve keys for operating each type of manual valve. (Manual drain valves, gate valves and angle valves).
   5. Two (2) valve keys and hose swivels for each type of quick coupling valve.

5.11 MAINTENANCE DURING PROJECT CONSTRUCTION

A. Within Limit of Work: Contractor shall fence, water, and keep weed free any turf, trees and any plantings within the Limit of Work. Contractor is responsible for maintenance which includes picking up trash, weed control and mowing of turf and native areas within the Limit of Work. Contractor is responsible for watering existing landscape within the Limit of Work. Turf and plants affected by mainline work or irrigation water service shutdown during irrigation season shall receive watering per Parks' schedule, with no interruption of watering greater than seventy-two (72) hours. The Contractor is responsible for maintenance until Final Acceptance is granted.

B. Outside Limit of Work: Coordinate Automatic Irrigation Controller scheduling and maintenance operations with Project Manager for portions of City property unaffected by Construction.

C. Additional Maintenance During Warranty Period:
   1. Make repairs and replacements needed due to defective workmanship and materials.
   2. Winterization: Include cost in bid for winterizing complete system at conclusion of irrigation season (during which system received Final Acceptance) within three (3)-days of notification by the City. System shall be voided of water using compressed air. Coordinate with the Denver Parks Operations Supervisor and the Project Manager to be present during the winterization procedures. The Contractor shall notify all persons that are to be present a minimum of forty eight (48) hours prior to the winterization of the system.
   3. Spring Start Up: To take place the following season within three (3) days of notification by the City. Open, operate, adjust system, and make any necessary repairs. Coordinate with the Denver Parks Operations Supervisor and the Project Manager to be present during the spring start up procedures. The Contractor shall notify all persons that are to be present at the spring start up a minimum of forty-eight (48) hours prior to starting of the system.

PART 6 - PRODUCTS

6.1 GENERAL

A. Equipment must have performance characteristics to operate per the design conditions indicated. If any discrepancy or conflict exists between the quantities of equipment listed in the schedule and quantities shown on the Contract Drawings, the greater quantity shall govern.

B. All material shall be of the highest grade possible and where applicable, shall be marked accordingly and shall be new.

6.2 PIPE AND PIPE FITTINGS

A. Ductile Iron Pipe
1. Ductile Iron Pipe: Centrifugal cast ductile iron in metal molds for water pipe In accordance with ANSI C151 and AWWA A21.51 with asphaltic exterior coating and interior lining and coating in accordance with ANSI C151 and AWWA A21.51. Rubber-Gasket joints shall conform to ANSI/AWWA C111/A2.11.

B. Ductile Iron Fittings
1. All ductile iron fittings shall be made of class 350 ductile iron and shall have slanted, deep bell, rubber gasket style made in accordance with ASTM A-536, Grade 65-45-12 & AWWA C153. All fittings shall have a minimum of five (5) degree freedom of pipe deflection within the bell end.
2. All ductile iron pipe fittings, joint restraints and mainline isolation gate valves shall carry a minimum 10-Year warranty on any defective replacement products and labor replacement costs. Prior to the installation of pipe fittings, joint restraints and mainline gate valves, the manufacturer shall provide documentation stating the above warranty information in writing and signed by the Manufactures Representative.
3. All ductile iron fittings and joint restraints shall have a fusion bonded epoxy coating on interior and exterior of the product surface, average of ten to twelve mm (10-12) thickness. Epoxy coating shall conform to the requirements of CSA Z245.20-20 and NSF 61 for water services. Tar/bitumen coating will not be approved.

C. Copper Pipe and Fittings:
1. Pipe: Type K, rigid, hard tempered.
2. Fittings - Wrought copper, solder joint type. Joints - Soldered with solder, forty five percent (45%) silver, fifteen percent (15%) copper, sixteen percent (16%) zinc, and twenty four percent (24%) cadmium and solidus at 1125° F and liquids at 1145° F.

D. Main and Lateral Lines:
1. Main Lines (pressurized, downstream of backflow prevention units):
   a. Class 200 PVC BE, size one inch (1”) through two inch (2”).
   b. Class 200 PVC RT/Gasketed, size two and one-half inches (2-1/2”) and larger.
   c. Velocities in PVC mainline shall not exceed five feet (5’) per second.
   d. All PVC pipe shall conform to the requirements of Type 1-ASTM-D-2241.
2. High Density Polyethylene (HDPE) pipe
   a. Pressure rating DR 11 two hundred (200) PSI
   b. PE4710, ASTM F714.
      1) May be used by approval of the Project Manager for portions of irrigation system that require boring such as below trees and paving.

c. HDPE to PVC mainline and laterals require either an epoxy coated repair coupler with joint restraints and stainless-steel pipe stiffener or Series 730 Poly-Cam Transition Fitting or approved equal.

3. Polyvinyl Chloride (PVC)_ Lateral Lines
   a. Class 200 PVC BE, size one inch (1") to three inch (3").
   b. Velocities in PVC mainline shall not exceed five feet (5') per second.
   c. All PVC pipe shall conform to the requirements of Type 1-ASTM-D-2241.
4. Polyethylene Lateral Lines:
   a. One hundred (100) PSI High Density NSF Polyethylene Piping – one inch (1") minimum diameter.
   b. Velocity of water flow in polyethylene pipe shall not exceed seven and one half (7-1/2) feet per second.

E. Sleeving:
1. Horizontal sleeves under paved surfaces: Class 200 PVC.
2. Vertical sleeves for access to drains and valves: Class 200 PVC.
3. Horizontal sleeving for boring applications: DR 11 HDPE.

F. Brass Pipe and Fittings:
1. Brass Pipe: Eighty-five percent (85%) red brass, ANSI Schedule 40 threaded pipe.
2. Fittings: Medium brass, threaded one hundred twenty five (125) pound class.

G. Pipe and Fittings:
1. Identification Markings: Identify all pipe with following indelible markings:
   a. Manufacturer's name.
   b. Nominal pipe size.
   c. Schedule of class.
   d. Pressure rating.
   e. NSF (National Sanitation Foundation) seal of approval.
   f. Date of extrusion.
2. Class 200 PVC Pipe (pressurized mainline one and one-half inches (1-1/2") and smaller):
   a. Pipe will be assembled with Schedule 80 PVC fittings and solvent welded using ASTM-F-656 purple primer followed with heavy bodied ASTM-D-2564 cement.
3. Class 200 PVC Pipe (pressurized mainline two inches (2") and larger):
   a. Manufactured from virgin Polyvinyl Chloride compound in accordance with ASTM D2241 and ASTM D1784; cell classification 1254-B, Type 1, Grade 1.
   b. All fittings, service tees and pipe restraints shall be epoxy-coated ductile iron fittings.
4. Class 200 PVC Pipe (all lateral lines)
   a. Pipe will be assembled with Schedule 40 PVC fittings and solvent welded using ASTM-F-656 purple primer followed with heavy bodied ASTM-D-2564 cement.
5. High Density Polyethylene (HDPE)
   a. Must meet ANSI/AWWA C906, ASTM F714/D3035. Materials used for the manufacture of polyethylene pipe and fittings shall be made from PE 4710 high density polyethylene resin compound meeting cell classification 445574C/E per ASTM D3350. Certification ANSI/NSF 61/14. All fittings shall be installed using butt-fused fittings or thermo-fused fittings/couplings and must be approved by the Project Manager.
6. **[Polyethylene Lateral lines (non-pressure lateral lines):][*Include this if Polyethylene Pipe is part of the project.]**

a. [Manufactured from virgin polyethylene in accordance with ASTM D2239, designated as PE 3408. Maximum size two inches (2"); minimum size one inch (1").]

b. [Fittings: Manufactured in accordance with ASTM D2609; PVC Type 1 cell classification 12454-B.]

c. [Clamps: All stainless-steel worm gear screw clamps. Use two (2) clamps per connection on all insert fittings.]

6.3 DETECTABLE WARNING TAPE

A. Refer to Division 31 Section "Excavation and Backfilling of Trenches" for detectable warning tape requirements.

B. Tape shall be blue with "Caution Irrigation Line Buried Below" or purple with "Caution Recycled/Reclaimed Water Line Buried Below".

6.4 VALVES

A. Gate Valve or Isolation Valve:
1. Valve for one and one-half inch (1-1/2") and smaller mainline: Shall be Class 125, 304 Stainless Steel with screw-in bonnet, non-rising stem, left hand opening with a stainless steel cross top handle gate valve with clear waterway equal to full diameter of pipe. Able to withstand continuous working pressure of two hundred (200) PSI. Wheel type handle is unacceptable.
2. Valve for two inch (2") and larger mainline: Shall be epoxy coated interior and exterior ductile iron body which meets ASTM A-536, Grade 65-45-12, push-on, left-hand opening, square nut operated, resilient wedge, mechanical joint AWWA C153 gate valve with clear waterway equal to full diameter of pipe. Able to withstand continuous working pressure of two- hundred fifty (250) PSI. Wheel type handle is unacceptable.

B. Stop and Waste Valve
1. For once inch (1") through two inch (2") mainlines. Must meet ANSI/AWWA C800 standard and certified to NSF 61 and rated for 175 PSIG. One-piece, closed bottom body, with no metal to metal contact between plug and body. Mueller Mark II Oriseal H-10284N or approved equal.

C. Automatic Control Valve:
1. Automatic Valve for Potable Water System: Hunter ICV Series Valve having manual flow adjustment and both internal and external manual bleed. Accu Sync shall be used if pressure at the heads is greater than ten pounds over the optimal pressure as stated on the plans or measured in the field.
2. Automatic Valve for Non-Potable Water System: Hunter ICV with Filter Sentry Series. Accu Sync shall be used if pressure at the heads is greater than ten (10) pounds over the optimal pressure as stated per the manufactures catalog, plans, or measured in the field.
3. Valve Riser: Epoxy coated ductile iron riser with integral stainless-steel angle valve or approved equal.
4. Valve ID Tag: Install one flexible marker tag on each valve. Mark each tag with indelible ink indicating zone number. Tags shall be: Potable water systems (yellow), Non-potable systems (purple)

D. Manual Drain Valve:
   1. Drain Valve: Mueller Oriseal #H-10283N with brass swing joint assembly, or approved equal.

E. Quick Coupling Valves:
   1. Buckner QB44LRCAR10 brass two-piece body with winged stabilizer, designed for working pressure of one hundred fifty (150) PSI; one inch (1") FIP. Size as shown on drawing.
   2. Quick Coupling Valves immediately after the backflow are used for winterization and shall be constructed of all brass swing joint and fittings. All other Quick Coupling Valve swing joints shall be constructed as shown on the details.

F. Master Valve:
   1. Mainline two and one-half inch (2-1/2") and smaller, Master Valve shall be Superior 3100 normally open valve.
   2. Mainline three inch (3"), and larger, Master Valve shall be Bermad 410 normally open valve (Bermad 420 when pressure regulation is required).

G. Flow Meter Assembly:
   1. Mainline one inch (1") through twelve inch (12"), flow meter shall be FloMec QS-200, sized according to mainline size.

H. Valve Boxes:
   1. All valve boxes shall have a stainless steel hex bolt locking lid system.
   2. Isolation Valves, Quick Coupling Valves, Drain Valves, Wire Splices and Ground Rods: Shall be branded with equipment type as outlined in Part 3 - Execution.
      a. Rain Bird VB10RNDH, round body.

   3. Electric Control Valve Box: Shall be branded with the zone numbers as outlined in Part 3 - Execution.
      a. Three-quarter inch (3/4") through one inch (1") valves: Rain Bird VBSTDH, standard body.
      b. One and one-half inch (1-1/2") through two-inch (2") valves: Rain Bird VBJMBH, jumbo body.
      c. Sub-surface dripline valve assemblies: Rain Bird VBSPRH super jumbo body.
      d. One inch (1") through two and one-half inch (2-1/2") Master Valves: Rain Bird VBJMBH jumbo body.
      e. Three-inch (3") through six-inch (6") master valves: Rain Bird VB-MAX
      f. Flow Meter: VBJMBH maxi jumbo body.

   4. Valve box cover color:
      a. Green for potable systems.
      b. Purple for non-potable systems.

   5. Gravel Leveling Bed and Drainage Sump in Valve Boxes: three quarter inch (3/4") crushed gravel covered in geotextile fabric, as indicated on the Contract Drawings.

I. Backflow Preventer:
   1. High hazard, reduced pressure type, approved by University of Southern California (USC) or other approved testing laboratory; fully ported, ball-type gate valves on units 2-inch or smaller, as manufactured by Febco Model 825YA or approved equal. Resilient

gate valves on units larger than two inch (2"); as manufactured by Febco Model 880V or approved equal.

2. Backflow Preventer Cover: Guardshack enclosure of appropriate size, equipped with Lock Shield Brackets, manufactured by BPDI. Color: forest green.
3. Concrete Pad: Comply with Division 32 Section "Concrete Walks, Curbs and Miscellaneous Flatwork".

J. Air Relief Valve: On mainlines three inches (3") or larger, as per plan: Bermad C31 2-inch combination vacuum/air release valve or approved equal.

K. Pressure Regulating Valve (where water supply pressures exceed one-hundred (100) PSI):
1. Bermad 420 pressure regulating master valve for three inch (3") and larger mainlines.
2. Zurn 500XL3 pressure regulating valve for three-quarter inch (3/4") thru two and one-half inch (2-1/2") mainlines.

6.5 IRRIGATION HEADS

A. Heads: Provide swing joints of the type and size as indicated on the Contract Drawings. Heads of a specific type or function in the system shall be of the same manufacturer and shall be marked with the manufacturer's name and identification in such a position that they can be identified without being removed from the system.
1. Pop-Up Sprinkler Heads in turf areas: Rain Bird RD-06-S-F series.
   a. P30 for spray nozzles
   b. P45 for rotary nozzles
2. Pop-Up Sprinkler Heads in non-turf/native areas and shrub/flower bed areas: Rain Bird RD-12-S-F series.
   a. P30 for spray nozzles
   b. P45 for rotary nozzles
3. Pop-Up Sprinkler Heads for trees in native areas; Rain Bird RD-12-P45-S-F series with specified rotary nozzles as indicated on contract drawings.
4. Pop-Up Sprinkler Nozzles shall be Rain Bird MPR Series nozzle. Strip series and HE-VAN nozzles may be used for specific approved applications at the direction of the Project Manager.
5. Gear Driven Heads: Hunter I-20-06, I-20-12, I-25-06, I-40-06 with stainless steel risers, internal check valve, PRS and MPR as specified per Contract Drawings. Plastic risers are permitted on twelve-inch (12") rotor heads used in native areas. Minimum riser height shall be six inches (6") in turf areas.

B. Connections to Lateral Pipe:
1. Pop-up Heads: Shall be one-half inch (1/2") swing pipe, 0.49 inside dimeter with an operating pressure of eighty (80) PSI.
2. Gear Driven Heads: Shall be Rain Bird TSJ Series swing joints.

6.6 LOW VOLUME IRRIGATION

A. Valve: Hunter ICZ Drip Control Zone Kit with stainless steel filter and forty (40) pound pressure regulation, size per Contract Drawings.
1. Valve shall be installed in a valve box as noted in Section "Valve Boxes".

B. Supply Header: Class 200 PVC. All supply header piping to be installed at a twelve inch (12") depth.

C. Sub-surface Irrigation: Landscape Dripline, emitter spacing and flow as per Contract Drawings. All sub surface laterals to be buried at a minimum four inch (4") depth in soil.
   1. Flush valve installed in a round valve box as noted in Section "Valve Boxes".
   2. Operation Indicator Head - Rain Bird RD12 spray head with closed 6 series (orange) VAN nozzle shall be installed adjacent to flush valve at each end of the zone.

D. Sub-surface Dripline: Sixteen (16) to seventeen millimeter (17mm) flexible polyethylene tubing. Internal emitters to be pressure compensating and self-flushing to clear debris. Must be designed to prevent root intrusion by incorporating copper oxide into the product. Also must include a check valve and have a sealed outlet when system is not irrigating.

6.7 AUTOMATIC CONTROL SYSTEM

A. See Division 32 Section "Automatic Irrigation Controllers".

B. Electrical Control Wiring:
   1. Two Wire Systems:
      a. Two-Wire Decoder Cable – Two (2), #12 or #14 AWG UL. parallel wires each with single, solid copper conductors with polyethylene insulation. Wires shall be contained within separate polyethylene jacket. Cable shall be Regency Maxi Cable or Paige P7072D with red jacket (NO SUBSTITUTIONS).
         1) 14 AWG for up to twenty-five hundred feet (2500').
         2) 12 AWG for over twenty-five hundred feet (2500').
      b. Incoming (controller side) of the two-wire cable shall be identified by placing a black zip-tie tightly on the cable.
      c. Two-wire single station decoders Toro SB-DAC-1 to be installed in each valve box, one per valve. Decoders shall have a serial number engraved on each decoder for future identification. Decoder to be mounted on the inside wall of the valve box.
      d. Two-wire decoder cable shall have surge arrestors Toro SB-BLA installed every five hundred (500) ft. along two-wire path or every eight decoders whichever is the shortest distance. Surge arrestors are to be placed in valve box containing automatic control valve or in separate round valve box as noted in Section "Valve Boxes". Surge arrestor grounding shall be installed per manufacturer's recommendations.
      e. Copper wire shall be six (6) gauge bare solid copper wire connected to the ground rod using a Cadweld GR1161GPLUS "Plus One Shot" welding kit. Wire connection between surge arrestor and copper ground wire to be made using a high strength corrosion-resistant bronze alloy split-bolt.
      f. Two-Wire Splice Box: To be installed in a round valve box as noted in Section "Valve Boxes".
   2. Conventional Wire Systems:
      a. Electrical Control Wire for 24VAC Solenoid: Golf Course Sprinkler Wire - #12 to #14 AWG UL approved direct burial solid conductor copper wiring with polyethylene insulation 0.045-inch thickness.
      b. Electrical Common Wire: Golf Course Sprinkler Wire - #12 AWG UL approved direct burial solid conductor copper wiring with polyethylene insulation 0.045-inch thickness.
      c. Wire Colors: Match existing color system throughout.

C. Miscellaneous control wiring materials:

1. Materials for both standard and two wire systems.
    a. Data Wires: Paige 7171D-A direct burial shielded and armored signal cable with polyethylene jacket (NO SUBSTITUTIONS)
        1) Data Wire connections and splices shall be made with Ranger Servi-Seal.
    b. Control Wire and Two-Wire Decoder Cable connections and splices shall be made with 3M DBR/Y-6M direct bury splice, or approved equal, UL listed dry splice methods.
    c. Spare Wire and wire ends shall be capped with 3M DBR/Y.
    d. Mainline Tracer Wire: One (1) continuous #10 AWG UL approved direct burial solid conductor copper wiring with polyethylene insulation 0.045-inch thickness. tracer wire as detailed above all mainline.
    e. Splice Box: To be installed in a round valve box as noted in Section "Valve Boxes".

PART 7 - EXECUTION

7.1 PREPARATION

A. Utility Locates: Refer to Division 31 Section "Excavation and Backfilling of Trenches".

B. Landscape Plan Review and Coordination: Contractor will be held responsible for coordination between landscape and irrigation system installation. Landscape material locations shown on the Landscape Plan shall take precedence over the irrigation system equipment locations. If irrigation equipment is installed in conflict with the landscape material locations shown on the landscape plan, the Contractor will be required to relocate the irrigation equipment, as necessary, at Contractor's expense.

C. Pressure Verification: Contractor shall field verify the tap size, static pressure and verify gallons per minute flow at the project site, prior to commencing Work or ordering irrigation materials, and submit findings in writing to the Project Manager. If Contractor fails to verify tap size, static water pressure and flow prior to commencing Work or ordering irrigation materials, Contractor shall assume responsibility for all costs required to make system operational and the costs required to replace any damaged landscape material. Damage shall include all required material costs, design costs, labor costs and plant replacement costs.

D. Inspection: Examine areas and conditions under which Work of this Section is to be performed. Do not proceed with Work until unsatisfactory conditions have been corrected.
    1. Grading operations, with the exception of finish grading, shall be completed and approved by Project Manager before staking or installation of any irrigation system begins.

E. Layout: Layout and stake system before beginning installation. Staking shall occur as follows:
    1. Mark, with paint, routing of pressure supply line and valve boxes. Flag heads for all new zones. Contact the Project Manager forty-eight (48) hours in advance and request review of layout and staking. The Project Manager will review layout and direct changes if required. Review does not relieve installer from coverage problems due to improper placement of heads after staking.
    2. Valve boxes and mainline shall not be located in ball fields, multi-use sport fields, recovery zones, or below playground equipment.

3. If project has significant topography, free form planting beds, or other amenities which could require alteration of irrigation equipment layout as deemed necessary by the Project Manager, do not install irrigation equipment in these areas until the Project Manager has reviewed equipment staking.
4. The Project Manager will request the Office of the City Forester's approval of proposed trenching prior to start of trenching. The Contractor shall be following Division 01 Section "Tree Retention and Protection".
5. Review backflow prevention device location and operation with the Project Manager prior to mainline installation.

7.2 EXCAVATION AND BACKFILL

A. Refer to Division 31 Section "Excavation and Backfilling of Trenches".
   1. Directional Boring:
      a. Directional boring locations as indicated on the Contract Drawings.

   2. Clearances and Depths:
      a. Main pressure line: Make trenches of enough width to properly assemble and position pipe in trench.
      b. Clearances:
         1) Mainline and Lateral Piping clearance: Minimum clearance shall be two inches (2") horizontally on both sides of the pipe.
         2) Line Clearance: Provide minimum six inches (6") of clearance between each line, and minimum twelve inches (12") of clearance between lines of other trades.
         3) Installation of multiple runs of piping in one common trench is prohibited.

      c. Pipe and Wire Depth to finish grade:
         1) PVC Pressure Supply Piping: Twenty-six inches (26") to twenty-eight (28") from the top of pipe.
         2) HDPE Pressure Supply Piping: Thirty inches (30") to thirty-six inches (36") from the top of pipe.
         3) HDPE Lateral Lines: Eighteen inches (18") to twenty-four inches (24") from top of pipe.
         4) PVC Sleeving: At specified pipe or wire depth.
         5) Non-pressure Piping (gear driven heads): Eighteen inches (18") from top of pipe, maximum variation two inches (2").
            a) Native seed zones using twelve-inch (12") rotors: Twenty-four inches (24") from top of pipe, maximum variation two inches (2")
         6) Non-pressure Piping (pop-up heads): Eighteen inches (18") from top of pipe.
         7) Control Wiring and Two-Wire Decoder Cable: Side of mainline when installed in the same trench; twenty-four (24") inches deep when installed separately from the mainline trench.
   3. Vibratory Plow: Not permitted without written approval from the Project Manager.

7.3 INSTALLATION OF IRRIGATION EQUIPMENT

A. Locate all equipment as near as possible to locations designated. Deviations shall be reviewed and approved by the Project Manager prior to installation.

B. Service Line Piping (copper or ductile iron piping from water meter to connection to backflow prevention device) - When pipe installation is not in progress, or at the end of each day, close pipe ends with tight plug or cap.
   1. Ductile Iron Pipe – Provide and install full pipe length protective polyethylene factory-formed sleeves around all piping to be buried. Pipe shall be bedded per Denver Water current standards and specifications.
   2. Copper piping – Installation shall match specifications for copper service line as required by Denver Water and in accordance with City and County of Denver Building Codes.

C. Sleeving:
   1. Install sleeving under any hard surface prior to surface being installed to accommodate piping and wiring. If irrigation is not being modified, the Contractor shall work with the Project Manager and Park Operations to identify locations and size for sleeves for future use.
   2. Minimum depth to top of pipe shall be determined by depth of mainline and lateral lines. Sleeving depth shall match pipe and wire depth for all pressure and non-pressure piping installed under all hardscape surfaces, asphaltic concrete, or concrete paving.
   3. Sleeving under existing walks or concrete pavement shall be done by directional boring or hydraulic driving. Where cutting of asphalt and/or concrete is necessary, it shall be done per the Contract Drawings and Details and/or per the City and County of Denver Right of Way Standards. When cutting concrete, the entire section or "stone" must be removed from joint to joint. The Project Manager shall approve the final locations prior to removal.
      a. HDPE pipe may be used for sleeving when directional boring takes place under existing hard surfaces, walks, roadways, trees, etc.
      b. A sleeve is not required if the irrigation line is installed via directional boring with HDPE pipe as indicated by the Contract Documents.
   4. Compact backfill material in three uniform lifts, using mechanical tamping devices under pavement.
   5. Do not allow sleeves to become filled with soil or other undesirable material. Tape ends of sleeves until commencement of pipe installation.
   6. Mark sleeves on hard surfaces with a three inch (3") by three inch (3") "X" as per plans in a manner to ensure easy location in the future.
   7. Sleeve size requirements for wire and pipe, control wire shall be placed in sleeving separate from pipe sleeving:

a.	1" to 1-1/4" Pipe:	2" PVC
b.	1-1/2" to 2" Pipe:	4" PVC
c.	2-1/2" to 3" Pipe:	6" PVC
d.	4" Pipe:	8" PVC
e.	6" Pipe	10" PVC
f.	8" Pipe	12" PVC
g.	1 to 25 Control Wires:	2" PVC
h.	26 to 50 Control Wires:	3" PVC
i.	Two-Wire Decoder Cable:	2" PVC

D. Installation of Piping:
   1. PVC Mainlines:
      a. Ensure that pipe is placed at a consistent depth and on a level base free of rocks and stones. Place manual drain valves at low points and dead ends of pressure supply piping to insure complete drainage of system. When pipe laying is not in

progress, or at end of each day, close pipe ends with tight plug or cap. Perform Work in accordance with good practices prevailing in piping trades.

b. Install mainlines a minimum of thirty-six inches (36") off any hard surface and thirty-six inches (36") away from swales.

c. Solvent Weld PVC Pipe (required on all pipe two inch (2") or smaller and all PVC mainline within sleeves): Lay pipe and make all connections in accordance with manufacturer's recommendations. Do not install pipe when air temperature is below forty degrees (40°) F.

d. Gasketed End Pipe (required on all pipe two and one-half inches (2-1/2") or larger): Lay pipe and make pipe-to-fitting or pipe-to-pipe joint, following the manufacturer's recommendations. Install joint restraint fittings and pipe restraints on all fittings and adjacent pipe runs per manufacturer's recommendations and per the Contract Drawings.

2. PVC Lateral Lines:

a. Ensure that pipe is placed at a consistent depth and on a level base free of rocks and stones. When pipe laying is not in progress, or the end of each workday, close pipe ends with tight plug or cap. Perform Work in accordance with good practices prevailing in piping trades.

b. Install lateral lines a minimum of twelve inches (12") off any hard surface and thirty-six inches (36") away from swales.

c. Solvent Weld PVC Pipe (required on all lateral lines): Lay pipe and make all connections in accordance with manufacturer's recommendations. Do not install pipe when air temperature is below forty degrees (40°) F.

3. HDPE Lines:

a. All connections between HDPE pipe sections are to be made with fusion welded fittings per the manufacturer's recommendations.

b. All connections between HDPE and PVC are to be installed per manufacturer's recommendations.

c. All connection fittings between HDPE and PVC or any other pipe material being used are to be made a minimum of thirty-six inches (36") away from any hard surface.

E. Installation of Detectable Warning Tape:

1. Refer to Division 31 Section "Excavation and Backfilling of Trenches" for installation depths.

2. Detectable warning tape shall be installed on all irrigation mainline and lateral lines.

F. Joint restraints on all gasketed PVC mainline pipe two and one-half inch (2-1/2") and larger: Install joint restraints per the plans and or manufacturer's recommendations.

1. Joint restraints shall be installed as shown on the plans or per the manufacturer's recommendations. Prior to backfilling any joint restraints the Project Manager shall be present to verify that the restraints were installed in the proper locations and that all bolts have been tightened to the manufacturer's recommendations. Any restraints that are buried prior to inspection shall be excavated to allow for review and inspection at no additional cost to the City.

G. PVC Pipe Deflection

1. Solvent welded pipe will meet manufacturer's recommendations.

2. Gasketed pipe will not exceed one-inch (1") or two (2) degrees offset per twenty feet (20') in length.

H. **[Flexible Plastic (Polyethylene) Pipe: Lay pipe and assemble fittings according to manufacturer's recommendations and per the Contract Drawings and Details.]**

I. Control Wiring:
   1. Two-wire control wiring:
      a. Bury two-wire decoder cable between Automatic Irrigation Controller and electric valves in pressure supply line trenches, strung as close as possible to mainline with such cable to be consistently located to one side of pipe, or in separate trenches.
      b. Make wire/cable splices at electric control valve connections as follows:
         1) Two-wire cable to two-wire cable - watertight connectors.
         2) Two-wire cable to electric valve solenoid wires - watertight connectors.
         3) Install all two-wire decoder cable splices not occurring at control valve in a separate round valve box as noted in section "Valve Boxes".
   2. Standard Low Voltage Control Wire:
      a. Install one control wire for each control valve on standard low voltage wire systems.
      b. On standard low voltage wire systems install a total of five spare fourteen (#14) AWG UFUL control wires and one spare twelve (#12) AWG UFUL common wire from Automatic Irrigation Controller pedestal to the end of each leg of mainline. Label spare wires at Automatic Irrigation Controller and wire splice box.
      c. Make all splices and electric control valve connections using 3M DBR/Y connectors
   3. Bury control wiring between Automatic Irrigation Controller and electric valves in pressure supply line trenches, strung as close as possible to mainlines with such wires to be consistently located to one side of pipe, or in separate trenches.
      a. For standard low voltage wire systems bundle all twenty-four (24) volt wires at ten-foot (10') intervals.
   4. Provide an expansion loop at every mainline change of direction, every electric control valve location (in valve box), and every five hundred feet (500').
      a. Form expansion loop in each control valve box by wrapping twenty-four inches (24") of wire around a one-inch (1") pipe and withdrawing pipe.
      b. Leave seventy-two inches of extra two-wire cable in each valve box.
   5. Install all control wire splices not occurring at the control valve in a separate wire splice round valve box as noted in section "Valve Boxes".
   6. Wire Testing:
      a. Existing wiring indicated to remain on documents is to be ohm-tested for continuity prior to construction. The Contractor shall produce the report and copy the Project Manager of the results of such testing.
      b. New wiring: All new wiring to be tested for proper resistance prior to connection to valves and controller(s) for continuity. The Contractor shall produce the report and copy the Project Manager of the results of such testing.
   7. Tracer Wire:
      a. One (1) continuous #10 AWG UL twenty-four inches (24") looped into each valve box, gate valve and quick coupler, and terminated inside the irrigation controller cabinet. Installed per the Contract Drawings.
   8. Detectable Warning Tape:
      a. Refer to Division 31 Section "Excavation and Backfilling of Trenches".

J. Installation of Valves:
   1. Electric Control Valves: Install electric control valves as detailed on the Contract Drawings.

a. Electric Control Valves for two-wire system: Install electric control valves as detailed on the Drawings. Install one valve decoder module (Toro SB-DAC-1) per valve box.

2. All low volume irrigation shall be zoned independently from turf, and product applications may not be mixed within zone.
3. Quick Coupling Valves: Install quick coupling valves as detailed on the Contract Drawings.
4. Drain Valves: Install manual drain valves at all low points in pressure supply line, whether indicated on the Contract Drawings or necessitated by actual conditions, to ensure proper drainage of the mainline.
5. Isolation/Gate Valves: Install as detailed in locations shown on the Contract Drawings.
6. Valve Boxes: Install one valve box for each type of valve as detailed. Install compacted gravel leveling bed after compaction of subgrade and prior to setting of valve box.
   a. Install geotextile fabric over gravel prior to setting valves boxes. Ensure that geotextile fabric extends a minimum of six inches (6") from the bottom and no more than six inches (6") from the top of box. Secure the geotextile fabric to the side of box with duct tape.
   b. Install valve boxes flush with finish grade and square to adjacent surface features and one another
   c. When valve boxes are grouped together, allow at least twenty-four inches (24") between valve box sides.
   d. Install valve boxes a minimum of eighteen inches (18") away from any hard surface.
   e. Cutting of valve boxes to give clearance for piping or valves is not permitted, except for the Master Valve and Flow Meter boxes.

K. Valve Box Identification Branding:
1. Brand Lids as follows in two inch (2") high, minimum letters:

a.	Isolation/Gate Valve	"GV"
b.	Quick Coupler Valve	"QC"
c.	Manual Drain Valve	"DV"
d.	Air Relief Valve	"AR"
e.	Master Valve	"MV"
f.	Flow Meter	"FM"
g.	Wire Splice Box	"WS"
h.	Grounding Rod	"GR"
i.	Filter	"FIL"

7.4 BACKFLOW PREVENTION

A. Backflow Prevention Device: Contractor must meet all applicable laws, rules and codes, including but not limited to Uniform Building codes and applicable amendments Plumbing Codes and State Water Regulations. Assemblies must be installed per the manufacturer's specifications.
1. Install in strict accordance with current requirements of Denver Water. Connections to the Denver Water System are to have an approved assembly for the type of protection they provide, either isolation or containment.
2. Successful Testing of backflow assembly by a certified Backflow Prevention Assembly Tester is Contractor's responsibility and any cost shall be considered incidental. Test reports shall be forwarded to Denver Water in accordance with the State of Colorado

regulations. Copies of the report, the tester's certification and the certification of the testing equipment used are to be forwarded to the Project Manager.

3. Request for final payment will not be certified or processed until certification reports have been filed with Denver Water and received by the Project Manager.

7.5 INSTALLATION OF SPRINKLER HEADS

A. Install sprinkler heads where designated after the Project Manager has approved staking. Set to finish grade as detailed.
   1. Spacing of heads shall not exceed the maximum indicated on the Contract Drawings unless re-staked or as directed by the Project Manager. In no case shall the spacing exceed maximum recommended by manufacturer, with the exception of native areas as shown in the Contract Documents.
   2. Install gear driven heads on swing-joint risers as detailed. Swing joints to non-pressure lines shall be set at no more than forty-five degrees (45°) or less than ten degrees (10°).
   3. Install pop-up heads on swing pipe as detailed.
   4. Adjust part circle heads for proper coverage. Adjust heads to correct height after sod is installed. Plant placement shall not interfere with intended sprinkler head coverage, piping, or other equipment. The Project Manager may request nozzle changes or adjustments without additional cost to the City.

7.6 BACKFILLING

A. Refer to Division 31 Section "Excavation and Backfilling of Trenches".
   1. Ensure backfill compaction is adequate so that settling does not occur.
   2. Repair of turfgrass areas shall be as follows:
      a. Seed is permitted for irrigation trenches up to twelve inches (12") in width.
      b. Sod is required for any turf repair wider than twelve inches (12") and shall be installed as full width.

7.7 ADJUSTING

A. Upon completion of installation, "fine-tune" entire system by regulating valves, adjusting arcs and radius, and setting pressure reducing valves at proper and similar pressure to provide optimum and efficient coverage. Flush and adjust all sprinkler heads for optimum performance and to prevent overspray onto walks, roadways, and buildings as much as possible. Heads of same type shall be operating at same pressure within plus or minus ten percent (10%).

B. If it is determined by the Project Manager or Denver Parks Operations Staff that irrigation adjustments will provide improved coverage and water distribution, the Contractor shall make such adjustments prior to Final Acceptance. Adjustments may include but not limited to changes in nozzle sizes, degrees of arc, and adjusting flow control. Adjustments shall be completed at no additional costs to the City.

C. All sprinkler heads shall be set perpendicular to finish grade or within allowable limits shown on Contract Drawings.

D. Areas that do not conform to designated operation requirements, due to unauthorized changes or poor installation practices, shall be immediately corrected at no additional cost to the City.

7.8 FIELD QUALITY CONTROL

A. Flushing: After piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads, quick coupler assemblies, and hose valves, thoroughly flush piping system under full head of water pressure from dead end fittings. Maintain flushing for five (5) minutes through furthermost valves. Cap risers after flushing.

B. Testing Pressurized Mainline: Prior to installing any plant materials (sod, seed, trees, shrubs, perennials) arrange and conduct pressure test(s) in the presence of the Project Manager. Arrange for testing a minimum of forty eight (48) hours in advance. The contractor is responsible to supply the hydrostatic test pump and all other equipment required to complete the test.
   1. Set in place, cap and pressure test all piping under paving, in presence of the Project Manager prior to backfilling and paving operations.
   2. After installation and backfilling of all control valves, fill pressure supply line with water, and pressurize to forty (40) PSI over the static pressure or to one hundred twenty (120) PSI, whichever is greater, for a test period of two (2) hours. Testing pressure not to exceed one hundred forty-five (145) PSI.
   3. All isolation valves, angle valves, ball valves and zone valve flow controls are to remain open during testing.
   4. Leakage, Pressure Loss:
      a. Solvent welded PVC Pipe: Test is acceptable if zero (0) pounds of pressure is evident during the test period.
      b. Gasketed Pipe: Test is acceptable if two (2) pounds of pressure or less is evident during the test period.
   5. Leaks: Detect and repair leaks. Replace defective PVC pipe with new full length pipe section. No pipe splices will be accepted within pipe sleeve. No PVC pressure couplings or slip-fix repair couplings will be allowed.
   6. Retest system until test pressure can be maintained for duration of test.

7.9 COMPLETION INSPECTION

A. Arrange for the Project Manager to be present. Provide a minimum of forty-eight (48) hours of notice in advance of walk-through.

B. Entire system shall be completely installed and operational and trenches shall be finish graded and sod and/or seed in place prior to scheduling of walk-through.

C. Electrically operate each zone in its entirety for the Project Manager the time of walk-through.

D. A project inspection walk through shall include but is not limited to the following:
   1. Contractor shall adjust, straighten and nozzle all heads prior to walk through. Review operation, coverage, head/nozzle adjustment, and system adjustment per specifications.
   2. Contractor shall have all valves boxes unlocked prior to walk through. Open valve boxes to confirm materials, geotextile fabric, gravel bedding, wire splices, compaction, elevation, workspace access within boxes, clearance from lid and bedding, locking mechanisms, and zone branding. Interior of boxes should be free of foreign material, only geotextile fabric shall be visible in the bottom of boxes. All valves must be tagged with zone identification, Christy's valve marker tags or equal and valve box lids must be branded with zone valve identification. Verify connections in all valve and wire splice boxes.

3. Contractor shall provide documentation that resistance tests for all spare common and hot wires and tracer wire has been performed and the results for ohms reading on each wire tested.
4. Confirm irrigation heads are at specified elevation and distance(s) from paved surfaces and curbs, plumb and soil compacted.
5. Inspect concrete size and elevation of pads for backflow assembly, booster pump, and controller enclosure pads. Confirm quality of concrete, finishes, access to the Irrigation Controller and spare conduit/sleeving as required for wiring.
6. Review trench and related excavation repair including backfill, compaction, fine grade, seed, and sod installation.
7. Review appropriate use of purple valve covers and other product as required for non-potable water applications.
8. Generate a punch list of items to be corrected, prior to Substantial Completion.
9. Furnish all materials and perform all work required to correct all inadequacies of coverage due to deviations from Contract Documents.

7.10 CLEANING

A. Maintain continuous cleaning operation throughout duration of Work. Dispose of, all trash, waste materials, debris and excess soil generated by installation of irrigation system, off-site, at no additional cost to the City. Contractor shall clear all debris, including, soil, from all paths, walks, roads, and other hard surface areas.

7.11 PROTECTION

A. The Contractor shall repair any damage that occurs from construction operations at no additional cost to the City.

B. Restrict vehicular and pedestrian traffic from areas where irrigation has been installed. Erect temporary fencing or barricades and install warning signs as required or directed by the Project Manager at no additional cost to the City.

PART 8 - MEASUREMENT AND PAYMENT

8.1 MEASUREMENT

A. Measurement will be made by the contract unit specified for Irrigation Systems. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

8.2 PAYMENT

A. Payment will be made at the **contract unit** price, and shall include required materials, transportation, equipment, labor, earthwork, trenching, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, and fine grading as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 80 00

SECTION 32 92 20 NATIVE SEEDING

PART 9 - GENERAL

9.1 RELATED DOCUMENTS

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Report Documentation
1. City and County of Denver - Regulated Asbestos Contaminated Soil Standard Operating Procedure (RACS SOP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, May 2, 2019 (see Appendix).
2. City and County of Denver – Guidance for Reuse of Soil on City Projects, Denver Department of Environmental Health – Environmental Quality Division, October 5, 2017 (see Appendix).
3. **[City and County of Denver – Standard Materials Management Plan (MMP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, November 13, 2019 (see Appendix).]**
4. **[List geotechnical, investigative trenching, MMP, PSRMP or related documentation including dates, authorship, etc. (see Appendix).]**

9.2 SUMMARY

A. This Section includes requirements for the installation of native seed, mulch, erosion control material (if applicable), and establishment of the seeded areas, to be achieved as outlined in these Specifications until Final Acceptance.

B. Related Sections: **[REMOVE ANY OF THE SECTIONS BELOW THAT DO NOT APPLY]**
1. Division 01 Section “Erosion and Sedimentation Control”.
2. Division 01 Section “Tree Retention and Protection”.
3. Division 31 Section “Earth Moving”.
4. Division 31 Section “Watering”.
5. Division 32 Section “Irrigation System”.
6. Division 32 Section “Soil Preparation”.
7. Division 32 Section “Topsoil”.
8. Division 32 Section “Turfgrass Seeding”.
9. Division 32 Section “Sodding”.
10. Division 32 Section “Trees, Plants, and Groundcovers”.
11. Division 32 Section “Landscape Management and Maintenance”.

9.3 REFERENCES

A. Comply with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act and be equal to or better in quality than the standards for Certified Seed.

9.4 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, herbicide, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments, soil conditioners and fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

F. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

G. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

H. Weeds: Including but not limited to Puncturvine, Field Bindweed, Dandelion, Jimsonweed, Diffuse, Spotted and Russian Knapweed, Quackgrass, Horsetail, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canada Thistle, Nutgrass, Blackberry, Tansy Ragwort, Bermuda Grass, Johnsongrass, Poison Ivy, Nut Sedge, Nimble Weed, Bent Grass, Barnyard Grass, Perennial Sorrel, Cheatgrass, Kochia, Prickly Lettuce, Feral Rye, and Brome Grass or any weed listed on Colorado Noxious Weed List and Watch List.

9.5 SUBMITTALS

A. See Division 01 Section “Submittals” for submittal requirements.

B. Materials: The Contractor shall submit to the Project Manager for approval a complete list of all materials to be used during this portion of the work prior to delivery of any materials to the site. Include complete data on source, amount and quality. This submittal shall in no way be construed as permitting substitution for specific items described on the plans or in these specifications unless approved in writing by the Project Manager.
   1. Certification of Seed: From seed vendor for each seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
   2. Native Grass Species (supplied as pure live seed): Submit lab germination test results for all grass species. Submit an affidavit that describes estimated purity for all forb species that are not typically tested.
   3. Pesticides: Include product label and manufacturer's application instructions specific to this Project.
   4. Soil Conditioners (if applicable): Include product label and manufacturer’s application instructions specific to the project.

5. Mulch: Include product label and manufacturer's application instructions specific to the project. The Contractor shall provide ship tickets to verify application rates.
6. Tackifier: Include product label and manufacturer's application instructions specific to the project.
7. Product Certificates: For soil amendments, soil conditioners and fertilizers, from the manufacturer.

C. Qualification Data: For qualified landscape Installer.

D. Pesticide application records, per State requirements.

E. Material Test Reports
1. Soil analysis for native soils at the project site: See Division 32 Section "Soil Preparation"
2. Analysis for each soil amendment.
3. Analysis for each soil conditioner.

F. Analysis and standards: Wherever applicable, for non-packaged materials, provide the analysis by a recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists.

G. Seeding schedule: Submit the proposed seeding schedule, indicating dates for site preparation, seeding, mulching, erosion control, and coordination with plant procurement, planting soil preparation, plant delivery and planting. Schedule all work during specified planting seasons. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.

H. Maintenance Instructions: Maintenance is per Division 32 Section "Landscape Management and Maintenance" if a maintenance Contract exists, or per the establishment subsection. Include recommended procedures for maintenance of irrigated and non-irrigated (if applicable) native seed areas during a calendar year. Submit before expiration of required initial maintenance or establishment periods.

I. Quarterly Reports: To ensure native seed is on track for establishment, provide reports to the Project Manager as outlined in Section "Establishment".

J. Contract Closeout Submittals:
1. Operating and Maintenance Data: At completion of work, submit one (1) digital copy to the Project Manager in accordance with Division 01 Section "Contract Closeout". Include directions for irrigation, aeration, mowing, fertilizing, and spraying as required for continued and proper maintenance through full growing season and dormant period.
2. Warranty for Native Seed Areas: At Substantial Completion submit a written warranty to the Project Manager based upon specified requirements.

9.6 QUALITY CONTROL

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful native grass establishment.
1. Experience: Five (5) years' experience in native seed installation in addition to requirements in Division 01 Section "Quality Control".

2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
3. Personnel Certifications: Installers shall have certification in the following categories from the NALP:
    a. Landscape Industry Certified Technician - Exterior, with installation maintenance irrigation specialty area(s).
4. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
5. Pesticide Applicator: Applicators shall be a Colorado State licensed, Commercial Applicator.

B. Soil Analysis: See Division 32 Section “Soil Preparation” and Division 32 Section “Topsoil”.

C. Pre-installation Conference: Conduct conference at the Project site to coordinate the seeding process with the Project Manager and other trades. This meeting shall include coordination of equipment movement within planting areas to avoid soil compaction, an overview of proposed methods of installation, review of the performance criteria and maintenance procedures, and an overview of underground utility location maps and plans. This meeting shall be coordinated by the Contractor and comply with requirements in Division 01.

D. Standards: All materials and methods used during this portion of the work shall meet or exceed applicable federal, state, county, and local laws and regulations. All seed shall be free from insects and disease. Species shall be true to their scientific name as specified.

E. Any native seed species substitutions shall be submitted to and approved by the Project Manager prior to installation.

F. All species shall be supplied as pure, live seed.

G. Equipment: The Contractor shall furnish all equipment free of noxious weeds, weed seed, plant material, and contaminated soil.

H. The Project Manager reserves the right to reject the seed at any time prior to Acceptance and that fails to meet specification requirements. Promptly remove rejected seed from site.

9.7 DELIVERY, STORAGE, AND HANDLING

A. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.

B. Seed and Other Packaged Materials: Shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the seed name, the lot number, net weight, origin, the percent of weed seed content, the guaranteed percentage of purity and germination, pounds of pure live seed (PLS) of each seed species, and the total pounds of PLS in the container. Seed that has become wet, moldy or damaged in transit or in storage will not be acceptable.

C. Soil Conditioner and Fertilizer: Deliver products to the site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law, and bearing name and warranty of producer.

D. Material will be inspected upon arrival at project site. Project Manager will reject any opened or unacceptable materials as described above. Store all materials in a manner to prevent wetting and deterioration.

E. Immediately remove unacceptable material from job site.

9.8 PROJECT/SITE CONDITIONS

A. Work scheduling: Proceed with and complete landscape work rapidly, as portions of the site become available, working within the specified planting season and approved schedule.

B. Vehicular accessibility on site shall be approved by the Project Manager

C. Seeding Season: Seeding shall generally occur during the specified windows below. Seeding dates may be modified when temperature and moisture conditions are favorable.

Seed Type	**Irrigated Areas Only**	**Non-Irrigated Areas**
Native Grasses	April 15-Sept.1	November 15-April 15

1. Dormant Seeding: Upon approval of the Project Manager, dormant seeding for Irrigated and Non-irrigated areas may be accomplished between November 15 and April 15. No seeding shall be done when the ground is frozen, muddy, covered with snow, or otherwise in a condition unsuitable for seeding. Dormant seeding will not relieve the Contractor from the Warranty or the Acceptance requirements specified elsewhere in this specification.

D. Coordination:
1. Coordinate with construction of utilities on site. Do not begin placing native seed until underground work is completed in the area.
2. Coordinate seeding with approved schedule. Limit construction access to areas where topsoil has been placed if placement is completed more than three (3) days prior to commencement of landscaping in the area. Limit fine grading to areas that can be prepared for planting within twenty-four (24) hours after fine grading.
3. No vehicular or equipment access shall be allowed within areas that have been seeded.
4. Coordinate with installation of underground irrigation system.

PART 10 - PRODUCTS

10.1 MATERIALS

A. Soil Preparation: See Division 32 Section "Soil Preparation".

B. Topsoil: See Division 32 Section "Topsoil".

C. General:

1. The selected seed mix must be approved by the Project Manager prior to its incorporation into the project.
2. All seed brands shall be free from Colorado prohibited noxious weed seeds, including but not limited to Canada Thistle, Field Bindweed, Johnsongrass, and Leafy Spurge. The Contractor shall furnish to the Project Manager a signed statement certifying that the seed is from a lot that has been tested by a recognized laboratory for seed testing within six months prior to the date of delivery.
3. Computation for quantity of seed required on the project is based on Pure Live Seed (PLS).
4. The formula used for determining the quantity of PLS shall be:
   Pounds of Seed x (Purity x Germination) = Pounds of PLS.
5. If seed available on the market does not meet the minimum purity and germination specified, the Contractor must compensate for a lesser percentage of purity or germination by furnishing sufficient additional seed to equal the specified product. Product comparison shall be made on the basis of PLS in pounds, stated on each seed bag.
6. **[The use of the Cover Crop outlined in Section "Seed Mixes" is acceptable at a rate not to exceed one percent (1%) of the total PLS for the associated seed mixes selected. The use of a cover crop addition is contingent upon approval of the Project Manager.]**

D. Seed Mixes: **[REMOVE ANY OF THE SEED MIXES BELOW THAT DO NOT APPLY – OPTION TO IMPLEMENT EACH SEED MIX WITH FORBS OR WITHOUT FORBS.]**

1. Short Grass Mix (with forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Graminoids				
Bouteloua dactyloides	Buffalograss	10.0	11	7
Bouteloua curtipendula	Sideoats grama	4.5	20	13
Bouteloua gracilis	Blue grama	1.5	27	17
Elymus elymoides	Bottlebrush squirreltail	2.0	9	6
Koeleria macrantha	Prairie junegrass	0.5	21	13
Nassella viridula	Green needlegrass	1.2	5	3
Pascopyrum smithii	Western wheatgrass	4.2	13	8
Sporobolus cryptandrus	Sand dropseed	0.1	6	4
	Graminoid Totals	**24.0**	**111**	**72**
Forbs				
Artemesia frigida	Prairie sagewort	0.1	10	7
Machaeranthera tanacetifolia	Tanseyleaf tansyaster	1.0	9	6
Ratibida columnifera	Upright prairie coneflower	0.6	10	7
Sphaeralcea coccinea	Scarlet globemallow	0.9	10	7
Vicia americana	American vetch	5.0	4	3
	Forb Totals	**7.6**	**44**	**28**
	Total	**31.6**	**155**	**100**

Drill Seeded Rate:	31.6 PLS#/Acre
Mechanical Broadcast Rate:	31.6 PLS#/Acre
Hand Broadcast Areas Rate:	63.2 PLS#/Acre

2. Short Grass Mix (without forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Bouteloua curtipendula	Sideoats Grama	4.9	21	16.45
Bouteloua gracilis	Blue Grama	2.0	36	28.00
Buchloe dactyloides	Buffalograss	10.8	12	9.18
Elymus elymoides	Bottlebrush Squirreltail	2.0	9	6.82
Koeleria cristata	Prairie Junegrass	0.5	22	17.22
Nassella viridula	Green Needlegrass	1.4	6	4.33
Sporobulus cryptandrus	Sand Dropseed	0.1	10	7.82
	Total	**26.1**	**130**	**100**

Drill Seeded Rate: 26.1 PLS#/Acre
Mechanical Broadcast Rate: 26.1 PLS#/Acre
Hand Broadcast Areas Rate: 63.2 PLS#/Acre

3. Mid Grass Mix (with forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Graminoids				
Achnatherum hymenoides	Indian ricegrass	3.5	8	6
Bouteloua curtipendula	Sideoats grama	4.0	18	12
Bouteloua gracilis	Blue grama	1.0	18	12
Hesperostipa comata	Needle and thread	3.0	8	5
Koeleria macrantha	Prairie Junegrass	0.3	10	7
Panicum virgatum	Switchgrass	1.0	9	6
Pascopyrum smithii	Western wheatgrass	5.0	15	10
Schizachyrium scoparium	Little bluestem	3.0	13	9
Sporobolus cryptandrus	Sand dropseed	0.1	10	6
	Graminoid Totals	**20.8**	**110**	**72**
Forbs				
Dalea purpurea	Purple prairie clover	1.5	10	7
Amorpha canescens	Leadplant	6.0	11	7
Vicia americana	American vetch	5.0	4	3
Sphaeralcea coccinea	Scarlet globemallow	0.8	9	6
Machaeranthera tanacetifolia	Tanseyleaf tansyaster	1.0	9	6
	Forb Totals	**14.3**	**43**	**28**
	Total	**35.1**	**152**	**100**

Drill Seeded Rate: 35.1 PLS#/Acre

Mechanical Broadcast Rate:	35.1 PLS#/Acre
Hand Broadcast Areas Rate:	70.2 PLS#/Acre

4. Mid Grass Mix (without forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Achnatherum hymenoides	Indian Ricegrass	1.3	3	2.45
Bouteloua curtipendula	Sideoats Grama	5.9	26	20.00
Bouteloua gracilis	Blue Grama	2.0	35	27.24
Koeleria cristata	Prairie Junegrass	0.5	22	16.75
Panicum virgatum	Switchgrass	0.7	6	4.54
Pascopyrum smithii	Western Wheatgrass	2.1	6	4.95
Schizachyrium scoparium	Little Bluestem	3.7	17	12.71
Sporobulus cryptandrus	Sand Dropseed	0.1	10	7.61
Stipa comata	Needle and Thread	1.8	5.0	3.75
	Total	**18.1**	**130**	**100**

Drill Seeded Rate: 18.1 PLS#/Acre
Mechanical Broadcast Rate: 18.1 PLS#/Acre
Hand Broadcast Areas Rate: 36.2 PLS#/Acre

5. Sandhill Prairie Mix (with forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Graminoids				
Achnatherum hymenoides	Indian ricegrass	5.0	12	8
Andropogon gerardii	Big bluestem	3.8	11	7
Andropogon hallii	Sand bluestem	4.0	10	7
Calamovilfa longifolia	Prairie Sandreed	2.0	13	8
Panicum virgatum	Switchgrass	1.0	9	6
Pascopyrum smithii	Western wheatgrass	4.5	14	9
Schizachyrium scoparium	Little bluestem	3.0	13	8
Sorghastrum nutans	Indiangrass	4.0	16	10
Sporobolus cryptandrus	Sand dropseed	0.1	13	8
	Graminoid Totals	**27.4**	**110**	**70**
Forbs				
Eriogonum umbellatum	Sulphur-flower buckwheat	2.0	10	6
Gaillardia aristata	Blanket flower	2.5	8	5
Heterotheca villosa	Hairy false goldenaster	0.8	12	7
Penstemon angustifolius	Broadbeard beardtongue	1.5	9	6
Ratibida columnifera	Upright prairie coneflower	0.6	10	6
	Forb Totals	**7.4**	**48**	**30**
	Total	**34.7**	**159**	**100**

Drill Seeded Rate: 34.7 PLS#/Acre
Mechanical Broadcast Rate: 34.7 PLS#/Acre
Hand Broadcast Areas Rate: 69.4 PLS#/Acre

6. Sandhill Prairie Mix (without forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Achnatherum hymenoides	Indian Ricegrass	1.8	4	3.28
Andropogon gerardii	Big Bluestem	7.8	23	17.85
Andropogon hallii	Sand Bluestem	2.8	7	5.64
Calamovilfa longifolia	Prairie Sandreed	4.9	31	23.85
Panicum virgatum	Switchgrass	0.9	8	6.09
Schizachyrium scoparium	Little Bluestem	4.9	22	17.04
Sorghastrum nutans	Indiangrass	7.1	28	21.22
Stipa comata	Needle and Thread	2.5	7	5.02
	Total	**32.7**	**130**	**100**

Drill Seeded Rate: 32.7 PLS#/Acre
Mechanical Broadcast Rate: 32.7 PLS#/Acre
Hand Broadcast Areas Rate: 65.4 PLS#/Acre

7. Riparian Prairie Mix (with forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Graminoids				
Andropogon gerardii	Big bluestem	3.0	9	6
Calamovilfa longifolia	Prairie sandreed	2.0	13	8
Elymus canadensis	Canada wildrye	10.0	23	15
Elymus trachycaulus	Slender wheatgrass	4.8	16	10
Panicum virgatum	Switchgrass	2.5	22	14
Pascopyrum smithii	Western wheatgrass	5.5	17	11
Spartina pectinata	Prairie cordgrass	2.5	11	7
	Graminoid Totals	**30.3**	**110**	**70**
Forbs				
Asclepias speciosa	showy milkweed	6.0	8	5
Helianthus nuttalli	Nuttal's sunflower	2.0	10	6
Iris missouriensis	Rocky Mountain iris	6.0	3	2
Monarda fistulosa	Wild bergamot	0.5	15	9
Solidago canadensis	Canada goldenrod	0.8	12	8
	Forb Totals	**15.3**	**48**	**30**

Total	**45.5**	**158**	**100**

Drill Seeded Rate: 45.5 PLS#/Acre
Mechanical Broadcast Rate: 45.5 PLS#/Acre
Hand Broadcast Areas Rate: 91.0 PLS#/Acre

8. Riparian Prairie Mix (without forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Andropogon gerardii	Big Bluestem	1.8	5	4.12
Calamovilfa longifolia	Prairie Sandreed	5.6	35	26.90
Elymus canadensis	Canada Wildrye	12.0	28	21.12
Elymus trachycaulus	Slender Wheatgrass	1.8	6	4.67
Panicum virgatum	Switchgrass	0.8	7	5.49
Pascopyrum smithii	Western Wheatgrass	5.1	16	11.94
Spartina pectinata	Prairie Cordgrass	8.0	34	25.76
	Total	**35.1**	**130**	**100**

Drill Seeded Rate: 35.1 PLS#/Acre
Mechanical Broadcast Rate: 35.1 PLS#/Acre
Hand Broadcast Areas Rate: 70.2 PLS#/Acre

9. Wetland Mix (with forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Graminoids				
Beckmannia syzigachne	American sloughgrass	0.6	16	10
Carex nebrascensis	Nebraska sedge	1.0	15	10
Eleocharis palustris	Creeping spikerush	1.0	14	9
Elymus canadensis	Canada wildrye	3.3	8	5
Panicum virgatum	Switchgrass	1.6	14	9
Pascopyrum smithii	Western wheatgrass	4.0	12	8
Schoenoplectus acutus	Hardstem bullrush	1.3	8	5
Schoenoplectus maritimus	Alkali bullrush	1.3	7	5
Spartina pectinata	Prairie cordgrass	3.5	15	9
	Graminoid Totals	**17.6**	**110**	**69**
Forbs				
Asclepias incarnata	swamp milkweed	8.0	13	8
Asclepias speciosa	showy milkweed	7.5	10	6
Helianthus maximilliani	Maximillian sunflower	2.5	13	8

Verbena hastata	Blue vervain	0.4	15	9
	Forb Totals	**18.4**	**50**	**31**
	Total	**36.0**	**160**	**100**

Drill Seeded Rate: 36.0 PLS#/Acre
Mechanical Broadcast Rate: 36.0 PLS#/Acre
Hand Broadcast Areas Rate: 72.0 PLS#/Acre

10. Wetland Mix (without forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Graminoids				
Beckmannia syzigachne	American sloughgrass	0.8	21	15.78
Carex nebrascensis	Nebraska sedge	1.2	19	14.55
Eleocharis palustris	Creeping spikerush	0.9	13	9.92
Elymus canadensis	Canada wildrye	3.3	7	5.72
Panicum virgatum	Switchgrass	1.6	15	11.15
Pascopyrum smithii	Western wheatgrass	3.3	14	10.46
Schoenoplectus acutus	Hardstem bullrush	1.6	11	8.34
Schoenoplectus maritimus	Alkali bullrush	1.4	8	5.83
Spartina pectinata	Prairie cordgrass	7.8	24	18.25
	Total	**36.0**	**160**	**100**

Drill Seeded Rate: 21.8 PLS#/Acre
Mechanical Broadcast Rate: 21.8 PLS#/Acre
Hand Broadcast Areas Rate: 43.6 PLS#/Acre

11. Water Quality Facility Mix (with forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Graminoids				
Elymus canadensis	Canada wildrye	4.5	10	6
Elymus trachycaulus	Slender wheatgrass	5.0	17	11
Panicum virgatum	Switchgrass	2.0	18	11
Pascopyrum smithii	Western wheatgrass	6.0	18	11
Schizachyrium scoparium	Little bluestem	2.5	11	7
Sorghastrum nutans	Yellow Indiangrass	7.0	27	17
Spartina pectinata	Prairie cordgrass	2.0	8	5
	Graminoid Totals	**29.0**	**110**	**69**
Forbs				
Coreopsis tinctorial	Plains coreopsis	0.2	11	7
Dalea candida	White prairie clover	1.0	8	5
Dalea purpurea	Purple prairie clover	1.5	10	6
Gaillardia aristata	Blanket flower	3.0	9	6
Ratibida columnifera	Upright prairie coneflower	0.7	12	7
	Forb Totals	**6.4**	**50**	**31**
	Total	**35.4**	**160**	**100**

Drill Seeded Rate: 35.4 PLS#/Acre
Mechanical Broadcast Rate: 35.4 PLS#/Acre
Hand Broadcast Areas Rate: 70.8 PLS#/Acre

12. Water Quality Facility Mix (without forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Elymus canadensis	Canada wildrye	12.0	28	21.12
Elymus trachycaulus	Slender wheatgrass	1.8	6	4.67
Panicum virgatum	Switchgrass	0.8	7	5.49
Pascopyrum smithii	Western wheatgrass	5.1	16	11.94
Schizachyrium scoparium	Little bluestem	1.8	5	4.12
Sorghastrum nutans	Yellow Indiangrass	5.6	35	26.90
Spartina pectinata	Prairie cordgrass	8.0	34	25.76
	Total	**35.4**	**160**	**100**

Drill Seeded Rate: 35.1 PLS#/Acre

Mechanical Broadcast Rate: 35.1 PLS#/Acre
Hand Broadcast Areas Rate: 70.2 PLS#/Acre

13. Shade Tolerant Mix (with forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Graminoids				
Bouteloua curtipendula	Sideoats grama	3.50	15	12
Elymus canadensis	Canada wildrye	3.50	8	6
Elymus trachycaulus	Slender wheatgrass	4.00	14	10
Festuca idahoensis	Idaho fescue	2.00	21	16
Koeleria macrantha	Junegrass	0.40	21	16
Poa secunda	Sandberg bluegrass	0.75	16	12
Pascopyrum smithii	Western wheatgrass	5.50	17	13
	Graminoid Totals	**19.65**	**112**	**86**
Forbs				
Achillea lanulosa	Western yarrow	0.04	4	3
Antennaria parvifolia	Pussytoes	0.30	8	6
Erigeron speciosus	Aspen daisy	0.10	4	3
Monarda fistulosa	Wild bergamot	0.10	3	2
	Forb Totals	**0.54**	**18**	**14**
	Total	**20.19**	**130**	**100**

Drill Seeded Rate: 20.19 PLS#/Acre
Mechanical Broadcast Rate: 20.19 PLS#/Acre
Hand Broadcast Areas Rate: 40.38 PLS#/Acre

14. Shade Tolerant Mix (without forbs):

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Graminoids				
Bouteloua curtipendula	Sideoats grama	4.00	18	14
Elymus canadensis	Canada wildrye	3.50	8	6
Elymus trachycaulus	Slender wheatgrass	4.00	14	10
Festuca idahoensis	Idaho fescue	2.00	21	16
Koeleria macrantha	Junegrass	0.60	32	25
Poa secunda	Sandberg bluegrass	1.00	21	16
Pascopyrum smithii	Western wheatgrass	5.50	17	13
	Total	**20.60**	**130**	**100**

Drill Seeded Rate: 20.6 PLS#/Acre
Mechanical Broadcast Rate: 20.6 PLS#/Acre
Hand Broadcast Areas Rate: 41.2 PLS#/Acre

15. **[Cover Crop:]**

Scientific Name	Common Name	PLS lbs/ac	PLS/sq ft	% of PLS/sf
Triticum aestivum x Secale cereale	Sterile triticale	60	18	100
	Total	**60**	**18**	**100**

Drill Seeded Rate: 60.0 PLS#/Acre
Mechanical Broadcast Rate: 70.0 PLS#/Acre
Hand Broadcast Areas Rate: 80.0 PLS#/Acre

E. **[Mulch:]**
1. **[Straw: Shall be certified weed free. Straw in a stage of decomposition will not be accepted.]**
2. **[Engineered Wood Strand Erosion Control Mulch: All wood material composed of loose, thin wood pieces with a high length to width ratio. Predominant species shall be Lodge-pole Pine, Hemlock, White Fir, Douglas Fir, and other conifer species with no more than ten percent (10%) fine material or dust. Shall be free of noxious weeds and chemicals.]**
   a. **[Length: 2 ½" to 8".]**
   b. **[Width: 3/16".]**
   c. **[Thickness: 1/10" to 1/7".]**
3. **[Hydromulch: Shall consist of virgin wood fibers manufactured from clean, whole wood chips. Fiber shall not be produced from sawdust, paper, cardboard, or residue from paper pulp. The fiber mulch shall be dyed green and shall be biodegradable and not inhibit plant growth. The wood cellulose fiber shall consist of the following properties:]**
   a. **[Percent Moisture Content: 10.0% +/- 3.0%.]**
   b. **[Percent Organic Matter: 99.3% +/- 0.2%.]**
   c. **[Percent Ash Content: 0.7% +/- 0.2%.]**
   d. **[pH: 4.9 +/- 0.5.]**
   e. **[Water Holding Capacity: 1200-1600 grams.]**
   f. **[Hydromulch is only acceptable for irrigated applications]**

F. **[Tackifier: Tackifier shall consist of free flowing, non-corrosive powder produced from the natural plant gum of Plantago insularis (desert Indianwheat). The powder shall consist of the following properties:]**
1. **[Protein Content: 1.6 +/- 0.2%]**
2. **[Ash Content: 2.7 +/- 0.2%.]**
3. **[Fiber: 4.0 +/- 0.2%.]**
4. **[pH 1% Solution: 6.5-8.0.]**

G. Fertilizer and Soil Conditioner: None required unless otherwise specified by soils test.

H. Water: Contractor to utilize the existing irrigation system and or quick coupler(s) when available. If irrigation or quick coupler(s) are not available then the Contractor is responsible to bring water to the site for watering. Water shall be free of substances that may be harmful to seed growth. Hoses and other watering equipment necessary to water the seed to be furnished by Contractor.

10.2 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use 'Restricted Use' pesticides unless authorized in writing by Project Manager and authorities having jurisdiction.

B. Ensure that applications adhere to the product label for restrictions and landscape sites.

C. Selective for either of the following types:
1. Broadleaf:
   a. 2,4-D Amine,
   b. Clopyralid,
   c. Aminopyralid,
   d. Triclopyr,
   e. Or approved equal.
2. Grasses:
   a. Imazapic,
   b. Indaziflam,
   c. Or approved equal.

D. Non-Selective: Broadleaf or Grasses
1. Glyphosate,
2. Or approved equal.

10.3 EROSION CONTROL MATERIALS

A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (6") long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with fifty (50%) to sixty-five (65%) percent open area. Include manufacturer's recommended steel wire staples, 6 inches (6") long.

C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3 inch (3") nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Invisible Structures, Inc.; Slopetame 2.
   b. Presto Products Company, a business of Alcoa; Geoweb.
   c. Tenax Corporation - USA; Tenweb.

10.4 SUBSTITUTIONS

A. All substitutions shall be submitted to and approved by the Project Manager prior to installation.

PART 11 - EXECUTION

11.1 SITE EXAMINATION

A. Examine areas to be seeded for compliance with requirements and other conditions affecting performance.
   1. Grades shall be in conformance with Division 31 Section “Earth Moving”. Finish grades shall have consistent slopes as indicated on the Contract Drawings.
   2. Soil preparation of seeded areas shall be in conformance with Division 32 Section “Soil Preparation”.
   3. Verify that no foreign or deleterious material or liquid such as but not limited to, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a seeding area. If contamination is present in soil, remove the soil and contamination as directed by the Project Manager and replace with new soil.

B. Locate, protect, and maintain the irrigation system during seeding operations. Verify that the irrigation system is operable and a coverage test has been completed and approved prior to seeding by the Project Manager. Irrigation system components damaged during seeding operations shall be replaced or repaired to current Denver Parks irrigation standards at the Contractor’s expense.

C. Locate and protect existing underground utilities. Perform work in a manner to avoid damage. Hand excavate as required.

D. Protect grade stakes set by others until removal is directed by the Project Manager.

E. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, noxious materials or obstructions, notify Project Manager before planting.

11.2 PREPARATION

A. Notify the Project Manager at least seven (7) working days prior to start of seeding operations.

B. Utilize equipment having low unit pressure ground contact within seeding areas.

C. Limit subgrade preparation to areas that can be seeded within twenty-four (24) hours. Seeding beyond twenty-four (24) hours of preparation shall only be done with the approval of the Project Manager.

D. Uniformly moisten excessively dry soil that is not workable.

E. The Contractor shall prepare the soil of all areas to be seeded in accordance with the requirements of Division 32 Section “Soil Preparation”.
   1. Do not mix or place soils and soil amendments in frozen, dry, or excessively wet conditions.

2. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

F. Weed Control: See Division 32 Section "Soil Preparation" for required weed control procedures. If weeds are present on-site, treat with pesticide prior to preparing soil for installing seed. Do not proceed with planting until the Project Manager have approved the specified and completed weed control measures.

G. Fine Grading: See Division 32 Section "Soil Preparation".
1. Verify all areas are graded to drain at a minimum of two percent (2%) or as indicated on the Contract Drawings. Maintain positive drainage, prevent ponding, and direct runoff into catch basins, drainage structures, etc., and provide a well -contoured surface prior to proceeding.
2. Verify that the subsurface drainage system and drain inlets, if present, are operative.
3. A firm weed-free seed bed is required. The seed bed shall be totally free from rock or clay clods or any other materials over one inch (1") in diameter. Remove sticks, roots, rubbish, and other extraneous matter and legally dispose of the off-site.
4. Obtain the Project Manager's approval of finished grade prior to proceeding with seeding operations.

H. Transition Grading: When areas of new seed abut existing areas, grade shall transition to prevent any abrupt grade breaks.

I. When grading is completed, the soil shall be firmed by float dragging, followed by steel raking, to provide for the proper seeded surface.

J. Ensure that all requirements that may be needed to break seed dormancy, as defined by the seed type are met, such as cold stratification, scarification, seed coat treatments, etc.

K. **[If turfgrass to native seed conversion is part of the Project, the Consultant shall develop a scope for site preparation for installation of native seed.]**

11.3 INSTALLATION OF NATIVE SEED

A. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the Project Manager.

B. Beginning of installation means acceptance of existing conditions by the Contractor.

C. Install native seed only after all other landscape and irrigation items have been installed and accepted by the Project Manager.

D. Seed shall be uniformly applied at the specified rate, (half in one direction and the other half perpendicular to the first application). The direction of the final application shall always be perpendicular to the slope or running in the direction of the contour. Seed shall be installed at a depth between one-quarter inch (1/4") and one-half inch (1/2").

E. Areas that are too small or steep for mechanical seeding may be hand seeded. Seed shall be uniformly applied at the specified rate utilizing a broadcast spreader and then hand raked in to a depth of no more than one-half inch (1/2"), then roll seed bed to ensure proper contact to the soil.

F. Do not drill or sow seed during windy, rainy weather or when ground is frozen or otherwise unable to be tilled.

G. Watering: Refer to Division 31 Section "Watering".

H. Review seasonal restrictions prior to seeding.

I. **[If turfgrass to native seed conversion is part of the Project, the Consultant shall develop a scope for installation of native seed.]**

11.4 PREPARATION FOR EROSION CONTROL MATERIALS

A. Review erosion control measures with the Project Manager prior to installation. The Contractor shall take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the site throughout the duration of work.

B. For erosion control mats, install planting soil in two (2) lifts, with second lift equal to thickness of erosion control mats. Install erosion control mat per manufacturer's recommendations.

C. Fill cells of erosion control mat with planting soil and compact before planting.

D. Install erosion control blanket on slopes exceeding 4:1, and in swales or other areas of concentrated runoff. As shown on the Contract Drawings or as directed by the Project Manager. Install in accordance with manufacturer's recommendations.

E. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by the manufacturer. Fasten the blanket per manufacturer's recommendations.

11.5 MULCHING

*****EDIT THE FOLLOWING LIST TO REFLECT SPECIFIC PROJECT CONDITIONS***[Straw Mulch Application: Straw shall be applied uniformly with no bare soil showing. It shall be crimped in with a crimper or other approved equipment. The seeded area shall be mulched within four (4) hours of seeding. Immediately apply tackifier evenly across the surface of straw mulch applications per the manufacturer's recommendations. Straw mulch may be used for irrigated or non-irrigated landscapes.]**

B. **[Engineered Wood Strand Erosion Control Mulch Application: Wood mulch shall be applied per manufacturer's recommendations. The seeded area shall be mulched within four (4) hours of seeding. Wood strand mulch may be used for irrigated or non-irrigated landscapes.]**

C. **[Hydromulch Application: Utilize an approved hydromulcher to apply cellulose fiber at a rate of two thousand (2,000) pounds per acre. The Contractor shall provide verification of application rates in the form of ship tickets. Hydromulch shall only be used for irrigated landscapes.]**

D. Mulching shall not be installed when surface water is present resulting from rain, melting snow, irrigation, or other causes.

E. Areas not properly mulched, or any damage that may occur during construction is the responsibility of the Contractor and shall be repaired and re-mulched in an acceptable manner at the Contractor's expense. Mulching removed by wind, rain, or other causes prior to acceptance shall be re-established by the Contractor at their own expense.

F. The seeded area shall be mulched within four (4) hours of seeding. Areas not mulched within twenty-four (24) hours after seeding must be re-prepped and re-seeded with the specified seed mix at the Contractor's expense.

11.6 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work. Remove all excess materials, debris and equipment from site.

B. Remove non-degradable erosion-control measures after the establishment period or at the direction of the Project Manager.

C. **[Protect adjacent and adjoining areas from hydromulching overspray. The Contractor shall remove all hydromulch from surface areas not specified for seeding, including but not limited to plant materials, fences, paved areas, signs, mulch beds, irrigation components and all other objects as directed by the Project Manager.]**

11.7 PROTECTION AND REPAIR

A. The Contractor shall protect existing utilities, irrigation, paving, and other facilities from damage caused by seeding operations. The Contractor shall repair any damage at their expense. Any areas outside the Contract Limits that are disturbed as a result of construction operations shall be restored to Parks standards at no additional cost to the City.

B. The Contractor shall repair damage to prepared topsoil and existing surfaces, caused by vehicular access and movement during work under this section, to original condition at no additional cost to the City.

C. The Contractor shall protect and restrict access from seeded areas until the areas are established and Accepted. Temporary fencing, barricades, and warning signs shall be installed as required, or by direction of the Project Manager at no additional cost to the City. Maintain fencing and barricades throughout the site until the Project Manager approves removal.

11.8 ESTABLISHMENT

A. If management and maintenance is required per the Contract, refer to Division 32 Section "Landscape Management and Maintenance".

B. If management and maintenance is not required per the Contract, then the native seed establishment is per the Acceptance sub-section. Maintenance of the native seed areas are the responsibility of the Contractor until Final Acceptance.

1. To ensure that native seed is on track for establishment, the Contractor shall submit Quarterly Progress Reports to the Project Manager outlining the Work completed, damage incurred, percent of cover, and undesirable species. Reports shall include digital photograph

documentation of the Work. The Contractor and the Project Manager shall also meet quarterly for review of the establishment.

11.9 ACCEPTANCE

A. Substantial Completion shall be granted when seed has been applied and stabilized or per the discretion of the Project Manager.

B. Final Acceptance will be granted when native seed areas are in a healthy, vigorous growing condition, and meet the listed Native Seed Establishment Criteria, until the establishment criteria has been met.

C. Native Seed Establishment Criteria.
   1. Irrigated native seed areas shall be established when the following criteria are met:
      a. Total vegetation cover in all zones shall exceed ninety (90%) by aerial cover, with a minimum of eighty (80%) being desirable species, and no more than ten (10%) being weedy species or bare ground. Sixty percent (60%) of the species diversity within the seed mix shall be present.
      b. If forbs are specified in the mix, at least (two) 2 species shall be present.
      c. At any time during the Contract period no more than ten percent (10%) by aerial cover of the seeded area shall be dominated by aggressive exotic species (weeds) such as, but not limited to, red clover (*Trifolium* spp.), white or yellow sweet clover (*Melilotus* spp.), Canada thistle (*Cirsium arvense*), tall fescue (*Festuca elatior*), field bindweed *(Convolvulus arvensis*), cheatgrass (*Bromus tectorum),* kochia (*Bassia scoparia*), etc.
      d. Until Final Acceptance, seeded areas that fail shall be replaced until they meet establishment criteria as required. Replacement materials shall be identical to those originally specified.
      e. Remedial Action: If seeded areas greater than ten (10) square feet fail to meet the terms of the guarantee shown above, the Contractor will develop and submit to the Project Manager a remedial action plan that takes into consideration the site goals and specific deficiencies causing the remedial action. The Contractor will implement the remedial action plan and submit a report that describes the remedial action taken. If remedial seeding or planting is required, Contractor will not be required to perform additional remedial seeding or planting in the same area for a minimum of two (2) growing seasons. After two (2) growing seasons following the remedial planting, the performance criteria must be met for the second growing season or additional remedial action must be taken. This guarantee remains in effect until all zones meet the third growing season criteria.
      f. Seeded areas will not be accepted in parts. Each time any portion or section of the entire seeded area requires replacement or remedial action, the establishment period shall extend until all seeded areas meet the minimum establishment requirements stated above.
      g. All expense incurred including repairs from vandalism for the replacement and or establishment of the seeded areas are the responsibility of the Contractor.
      h. If seeded in the fall, review for establishment shall be no later than June 15 of the following year.
      i. All Native Seeded areas shall be reviewed for a minimum period of one (1) year from the date of Substantial Completion to meet the Establishment Criteria. Any areas not

meeting the criteria per the Project Manager will need to be remined prior to acceptance.

2. **[Non-irrigated native seed:]**
   - **a. [Total vegetation cover in all zones seeded with cover crop shall exceed eighty percent (80%) by aerial cover with seventy percent (70%) being desirable species and no more than fifteen percent (15%) being weedy species or bare ground. Native seed shall be free of weeds, foreign grasses, disease and harmful insects.]**
   - **b. [At any time during the contract period no more than ten percent (10%) by aerial cover of the seeded area should be dominated by aggressive exotic species such as, but not limited to, red clover (*Trifolium* spp.), white or yellow sweet clover (*Melilotus* spp.), Canada thistle (*Cirsium arvense*), tall fescue (*Festuca elatior*), field bindweed *(Convolvulus arvensis*) etc.]**
   - **c. [During the original establishment period, reseed at the most appropriate time with approval of the Project Manager and with the original approved blend/mix to those areas that have failed to achieve healthy vegetation. Reseed to achieve quality as originally specified.]**
   - **d. [Reseeding will not be allowed outside of specified seeding seasons without prior approval by the Project Manager.]**

PART 12 - MEASUREMENT AND PAYMENT

12.1 MEASUREMENT

A. Measurement will be made by the contract unit specified for Native Seeding. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

12.2 PAYMENT

A. Payment will be made at the **contract unit** price, and shall include required materials, transportation, equipment, labor, earthwork, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, furnishing and installation of seeds and mulches installation and maintenance of temporary protection by fencing or other means, watering and all maintenance required until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 92 20

SECTION 32 92 23 SODDING

PART 13 - GENERAL

13.1 RELATED DOCUMENTS

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Report Documentation
1. City and County of Denver - Regulated Asbestos Contaminated Soil Standard Operating Procedure (RACS SOP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, May 2, 2019 (see Appendix).
2. City and County of Denver – Guidance for Reuse of Soil on City Projects, Denver Department of Environmental Health – Environmental Quality Division, October 5, 2017 (see Appendix).
3. **[City and County of Denver – Standard Materials Management Plan (MMP), Denver Department of Public Health and Environment (DDPHE) – Environmental Quality Division, November 13, 2019 (see Appendix).]**
4. **[List geotechnical, investigative trenching, MMP, PSRMP or related documentation including dates, authorship, etc. (see Appendix).]**

13.2 SUMMARY

A. This Section includes requirements for furnishing and installation of bluegrass sod, and establishment of sodded areas to be achieved as outlined in these Specifications until Final Acceptance.

B. Related Sections: **[REMOVE ANY OF THE SECTIONS BELOW THAT DO NOT APPLY]**
1. Division 01 Section “Tree Retention and Protection”.
2. Division 01 Section “Erosion and Sedimentation Control”.
3. Division 32 Section “Concrete Walks, Curbs, and Miscellaneous Flatwork”.
4. Division 32 Section “Irrigation System”.
5. Division 32 Section “Native Seeding”.

13.3 DEFINITIONS

A. Finished Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, pesticides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, herbicide, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

F. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

G. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

H. **[Turf Conversion: Areas of existing turfgrass to be converted to a different vegetation.]**

I. Weeds: Including but not limited to Puncturvine, Field Bindweed, Dandelion, Jimsonweed, Diffuse, Spotted and Russian Knapweed, Quackgrass, Horsetail, , Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canada Thistle, Nutgrass, Blackberry, Tansy Ragwort, Bermuda Grass, Johnsongrass, Poison Ivy, Nut Sedge, Nimble Weed, Bent Grass, , Perennial Sorrel, Cheatgrass, Kochia, Prickly Lettuce, Feral Rye, and Broom Grass or any weed listed on Colorado Noxious Weed List and Watch List.

13.4 SUBMITTALS

A. See Division 01 Section “Submittals” for submittal requirements.

B. Materials: The Contractor shall submit to the Project Manager for approval a complete list of all materials to be used during this portion of the work prior to delivery of any materials to the site. Include complete data on source, amount and quality. This submittal shall in no way be construed as permitting substitution for specific items described on the plans or in these specifications unless approved in writing by the Project Manager.
   1. Sod Certificates:
      a. State, Federal, and other inspection certificates for sod shall be provided to the Project Manager a minimum of ten (10) working days prior to anticipated date of sod delivery.
      b. Submit a list of varieties contained in the sod and include the source and origin for approval by the Project Manager.
   2. Pesticides (if applicable): Include product label and manufacturer's application instructions specific to this Project.
   3. Fertilizers (if applicable): Include product label and manufacturer’s application instructions specific to the Project.
   4. Product Certificates: For soil amendments and fertilizers, from manufacturer.

C. Qualification Data: Qualified Landscape Contractor.

D. Pesticide application records, per State requirements, if applicable.

E. Material Test Reports:

1. Soil analysis for native soils at the project site: See Division 32 Section “Soil Preparation”.

F. Analysis and standards: Wherever applicable, for non-packaged materials, provide digital copies of the analysis by a recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists.

G. Planting schedule: Submit in writing the proposed planting schedule, indicating dates for topsoil placing, site preparation, pesticide treatments, soil preparation, sodding, seeding, and coordination with plant procurement, planting soil preparation, plant delivery and planting. Schedule all work during specified planting seasons. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.

H. Maintenance Instructions: Procedures for management and maintenance per Division 32 Section “Landscape Management and Maintenance” or per establishment subsection.

I. Contract Closeout Submittals:
1. Operating and Maintenance Data: At completion of work, submit one (1) digital copy the Project Manager in accordance with Division 01 Section “Contract Closeout’. Include directions for irrigation, aeration, mowing, fertilizing and spraying as required for continued and proper maintenance through full growing season and dormant period.
2. Warranty for Turfgrass Sod Areas: At Substantial Completion, submit a written warranty to the Project Manager based upon specified requirements.

13.5 QUALITY CONTROL

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five (5) years' experience in turf installation in addition to requirements in Division 01 Section "Quality Control."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site when work is in progress.
4. Sod Producer: Company specializing in sod production and harvesting with minimum five (5) years’ experience, and certified by the State of Colorado Department of Agriculture.
5. Personnel Certifications: Installers shall have certification the following categories from the Professional Landcare Network:
   a. Certified Landscape Technician - Exterior, with installation maintenance irrigation specialty area(s), designated CLT-Exterior.
6. Maintenance Proximity: Not more than two (2) hours' normal travel time from Installer's place of business to Project site.
7. Pesticide Applicator: Applicators shall be a Colorado State Licensed, Commercial Applicator.

B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: See Division 32 Section “Soil Preparation” and Division 32 Section “Topsoil”.

D. Pre-installation Conference: Conduct conference at the Project site to coordinate the seeding process with the Project Manager, the City Naturalist, and other trades. This meeting shall include coordination of equipment movement within planting areas to avoid soil compaction, an overview of proposed methods of installation, review of the performance criteria and maintenance procedures, and an overview of underground utility location maps and plans. This meeting shall be coordinated by the Contractor and comply with requirements in Division 01.

E. Standards: All materials and methods used during this portion of the work shall meet or exceed applicable federal, state, county, and local laws and regulations. All sod shall be free from insects and disease. Species shall be true to their scientific name as specified.

F. Equipment: The Contractor shall furnish all equipment free of noxious weeds, weed seed, plant material, and contaminated soil.

13.6 DELIVERY, STORAGE, AND HANDLING

A. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver on pallets properly loaded on vehicles with root system protected from exposure to sun, wind, and heat in accordance with standard practice. Sod that has been damaged by poor handling or improper storage is subject to rejection by the Project Manager.
   1. Protect from dehydration, contamination, freezing and heating at all times. Keep stored sod moist and under shade or covered with moistened burlap.
   2. Do not drop sod rolls from carts, trucks or pallets.
   3. Do not deliver more sod than can be installed within twenty four (24) hours.

B. Bulk Materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

C. Fertilizer: Deliver inorganic or chemical fertilizer to site in original unopened container bearing manufacturer’s guaranteed chemical analysis, name, trade name, trademark, warranty and conformance to state law.

D. Material will be inspected upon arrival at project site. Project Manager will reject any opened or unacceptable materials as described above.

E. Immediately remove unacceptable material from job site.

13.7 PROJECT/SITE CONDITIONS

A. Work scheduling: Proceed with and complete landscape work as rapidly as portions of the site become available, work within the specified planting season and approved schedule.

B. Vehicular accessibility on site shall be approved by the Project Manager.

C. Install sod between April 15 and October 1 or when irrigation is available for twenty one (21) days per Denver Water's guidelines for sod establishment.

D. Schedule work for periods of favorable weather. Do not install sod on saturated or frozen soil. The Project Manager reserves the right to deny sod installation on days that are deemed to be unfavorable for installation.

E. Coordination:
   1. Coordinate with construction of utilities on site. Do not begin placing topsoil and sod until underground work is completed in the area.
   2. Coordinate sodding with the approved schedule. Limit construction access to areas where topsoil has been placed if placement is completed more than 3 days prior to commencement of landscaping in the area. Limit fine grading to areas that can be prepared for planting within twenty four (24) hours after fine grading.
   3. Coordinate with Contractors' work requiring access to site over sodded areas.
   4. Coordinate with installation of underground irrigation system.

13.8 WARRANTY

A. Warranty for Sodded Areas: Warrant sod areas to be in a healthy, vigorous growing condition, and for consistency and completion of coverage for a period of one (1) year from date of Substantial Completion as a full stand of grass. Re-sod any areas where sod has failed due to disease or other inadequate installation, as defined in this Section.
   1. During the original warranty period, immediately replace the sod with an approved sod blend/mix in the areas that have failed to achieve a full stand of grass or which are unhealthy.
   2. Re-sodding will not be allowed in any season considered unfavorable for sod installation as indicated in these Specifications. .

PART 14 - PRODUCTS

14.1 MATERIALS

A. Soil Preparation: See Division 32 Section "Soil Preparation.

B. Topsoil: See Division 32 Section "Topsoil".

C. Sod Standards:
   1. Colorado grown Kentucky Bluegrass blend having a healthy, vigorous root system. Blend shall contain a minimum of three (3) improved varieties, of which at least one variety is an aggressive type.
   2. Sod to be produced in accordance with requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding."
   3. Harvesting: Sod shall be fertilized two to three (2–3) weeks prior to harvesting. Mow sod to a height of one and one-half inches (1-1/2") before the sod is lifted. Sod shall be harvested in rolls, and shall not be cut more than 24 hours prior to planting.

4. Size: Machine cut to a minimum pad thickness of three quarters inch (3/4), excluding top growth and thatch. Provide sod of uniform pad sizes eighteen inches (18") minimum width by twenty four (24") minimum length, with maximum five percent (5%) deviation in either length or width. Broken pads or pads with uneven ends will not be acceptable. Sod pads incapable of supporting their own weight when suspended vertically from upper ten percent (10%) of pad will be rejected. Sod which has dried out, sod with adhering soil which breaks, tears, or crumbles away will not be accepted. Sod cut for more than twenty-four (24) hours will not be accepted.
5. Plastic netting: Sod to be free of plastic netting used during establishment by sod grower.
6. Inspection will be made periodically during sodding, at completion and at end of Warranty period by the Project Manager. Inspection is primarily for quality; however, other requirements are not waived even though visual inspection results in Acceptance.

D. Fertilizer: Inorganic mixture with following chemical composition: (20-5-10) with fifty percent (50%) of the nitrogen source being slow release, or as recommended by testing lab based on soil sample results.

14.2 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use 'Restricted Use' pesticides unless authorized in writing by the Project Manager and authorities having jurisdiction.

B. Selective for either of the following types:
1. Broadleaf:
   a. 2,4-D Amine,
   b. Clopyralid,
   c. Aminopyralid,
   d. Triclopyr,
   e. Or approved equal.
2. Grasses:
   a. Imazapic,
   b. Indaziflam,
   c. Or approved equal.

C. Non-Selective: Broadleaf or Grasses
1. Glyphosate,
2. Or approved equal.

14.3 SUBSTITUTIONS

A. All substitutions shall be submitted to and approved by the Project Manager prior to installation.

PART 15 - EXECUTION

15.1 SITE EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Grades shall be in conformance with Division 31 Section “Earth Moving”. Finish grades shall have consistent slopes as indicated on the Contract Drawings.

2. Verify soil preparation of all areas to be sodded are in accordance with the requirements of Division 32 Section “Soil Preparation”.
3. Verify that no foreign or deleterious material or liquid such as, but not limited to, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.

B. Locate, protect, and maintain the irrigation system during sodding operations. Verify that the irrigation system is operable, and a coverage test has been completed and approved prior to sodding by the Project Manager. Irrigation system components damaged during seeding operations shall be replaced or repaired to current Denver Parks irrigation standards at the Contractor’s expense.

C. Protect grade stakes set by others until removal is directed by the Project Manager.

15.2 PREPARATION

A. Work notification: Notify the Project Manager at least seven (7) working days prior to start of sodding operations.

B. Limit turf subgrade preparation to areas that can be sodded within twenty four (24) hours.

C. Uniformly moisten excessively dry soil that is not workable.

D. The Contractor shall prepare the soil of all areas to be sodded in accordance with the requirements of Division 32 Section “Soil Preparation”.
1. Do not mix or place soils and soil amendments in frozen, dry, or excessively wet conditions.
2. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

E. Weed Control: See Division 32 Section “Soil Preparation” for required weed control procedures. Do not proceed with planting until the Project Manager has approved the specified and completed weed control measures.

F. Fine Grading: See Division 32 Section “Soil Preparation”.
1. Verify all areas are graded to drain at a minimum of two percent (2%) or as indicated on the Contract Drawings. Maintain positive drainage, prevent ponding and direct run-off into catch basins, drainage structures, etc., and provide well-contoured surface prior to proceeding.

2. Verify that the subsurface drainage system and drain inlets, if present, are operative.
3. A firm weed-free seed bed is required. The seed bed shall be totally free from rock or clay clods or any materials over one inch (1") in diameter. Remove sticks, roots, rubbish, and other extraneous matter and legally dispose of them off-site.
4. Obtain the Project Manager's approval of finished grade prior to proceeding with seeding operations.

G. Transition Grading: When areas of new sod abut existing areas, sod shall be cut into existing grade to be flush and transition to prevent any abrupt grade breaks. Project Manager and Operations shall approve grading and transition.

H. When grading is completed the soil shall be firmed by float dragging, followed by steel raking, to provide for the proper sodded subgrade. The sod bed shall be totally free from rock or clay clods over one-half inch (1/2") inch in diameter.
1. Newly Graded Subgrades: Loosen subgrade to a minimum depth of six inches (6")
2. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
   a. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
   b. Loosen surface soil to a depth of at least 8 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top six inches (6") of soil. Till soil to a homogeneous mixture of fine texture.
   c. Remove stones larger than one-half (½") inch in any dimension and sticks, roots, trash, and other extraneous matter.
   d. Legally dispose of waste material, including grass, vegetation, and turf, off-site.

I. Adjustment: Adjust irrigation heads to proper watering height according to depth of sod material but lower than compacted blade height to enable lawn mowers to cut grass freely without damage to the sprinkler system.

J. Repair: Re-establish grade and specified conditions to damaged sod areas prior to placing sod.

K. Fertilizer: Fertilizer shall be applied topically once final grade has been established and just prior to sodding. Diamonium phosphate, bid quantity to be two (2) pounds of nitrogen per one thousand (1,000) square feet. Apply per manufacturers recommendations for the type of planting area, or per soil test recommendations.

15.3 INSTALLATION OF SOD

A. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the Project Manager.

B. Beginning of installation means acceptance of existing conditions by the Contractor.

C. Sod shall be installed for all turfgrass disturbance, except for irrigation trenches up to one foot (1') in width, refer to Division 32 Section "Turfgrass Seeding". Sod shall always be installed for disturbance adjacent to walks. Disturbance areas shall be prepared to receive full roll widths of sod.

D. Sodding:

1. Install sod during approved installation period (April 15 – October 1), unless otherwise approved by the Project Manager.
2. Any exposed areas not sodded within the approved installation period will require erosion control protection until sod can be installed.
3. Sod within twenty-four (24) hours after preparation of bed.
4. If plastic netting is present within sod, remove all netting during sod installation and discard from site.
5. Subgrade on which sod is laid shall be slightly moist during installation.
6. Lay sod at full roll width. Remove existing sod prior to installation of new sod to permit installation in 18" multiples, typical.
7. Lay sod with longest dimension parallel to contours and in continuous rows.
8. Tightly butt ends and sides of sod together. Stagger and compact vertical joints between sod strips.
9. Sod shall not be overlapped or stretched during placement. Exposed joints due to shrinkage will require replacement of sod in affected areas.

E. Topsoil: Where new sod abuts an existing turf area topsoil shall be placed along seams and or joints to provide a smooth transition.

F. Rolling: After sod and soil have dried, roll sodded areas after installation to ensure proper contact with the subgrade, remove minor depressions and irregularities, and ensure tight joints between adjacent pieces. Sod shall be moist prior to rolling. Once rolling is complete additional watering shall occur. Roller shall not exceed one hundred (100) pounds.

G. Water: Water shall be free of substances that may be harmful to sod growth. Hoses and other watering equipment necessary to water the sod to be furnished by Contractor.
1. Water thoroughly with a fine spray as laying progresses and immediately after planting. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of one and one half inches (1-1/2 ") below sod.

H. Review seasonal restrictions prior to sodding.

15.4 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work Remove all excess materials, debris, and equipment from site.

15.5 PROTECTION AND REPAIR

A. The Contractor shall protect existing utilities, irrigation, paving, and other facilities from damage caused by sodding operations. The Contractor shall repair any damage at their expense. Any areas outside the Contract Limits that are disturbed as a result of construction operations shall be restored to Parks standards at no additional cost to the City.

B. The Contractor shall repair damage to prepared topsoil and existing surfaces, caused by vehicular access and movement during work under this section, to original condition at no additional cost to the City.

C. The Contractor shall protect and restrict access from seeded areas until the areas are established and Accepted. Temporary fencing, barricades, and warning signs shall be installed as required, or by direction of the Project Manager at no additional cost to the City. Maintain fencing and barricades throughout the site until the Project Manager approves removal.

D. Erosion Control: Review erosion control measures with the Project Manager prior to installation. The Contractor shall take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the site throughout the duration of work.

15.6 ESTABLISHMENT

A. If management and maintenance is required per the Contract, refer to Division 32 Section "Landscape Management and Maintenance".

B. If management and maintenance is not required per the Contract, then the sod establishment is per the Acceptance sub-section.

C. Establishment of the sodded areas are the responsibility of the Contractor until Final Acceptance per the following requirements:

1. General: The establishment period shall begin immediately after each area is sodded and continue for Sixty (60) days or as determined by the Project Manager. During this time, the Contractor is responsible for watering, mowing, spraying, weeding, fertilizing and all related work as necessary to ensure that sodded areas are in a vigorous growing condition. Provide all supervision, labor, material and equipment to develop and maintain sodded areas from time of installation.
2. Mowing and Trimming: When turfgrasses reach three and one-half inches (3-1/2") in height, begin weekly mowing program to maintain turf at two and one-half inches (2-1/2") to three inches (3") in height. Do not remove more than 1/3 the height of the grass blade in single mowing. Do not mow when grass is wet. All clippings from adjacent paved areas shall be removed and clippings from mowed turf areas shall be removed to the satisfaction of Project Manager.
3. Fertilizing: Within thirty (30) days of sodding and every sixty (60) days thereafter until Acceptance, apply specified fertilizer to maintain optimal turf vigor or per the direction of the Project Manager.
4. Weed Control: Control annual weeds by mowing. Do not use pesticides unless approved by the Project Manager and Denver Parks Operations Supervisor.
5. Insect and Disease Control: As needed, apply insecticide and fungicide approved by the Project Manager and the Parks Operations Supervisor.

15.7 ACCEPTANCE

A. Substantial Completion of sod areas shall be granted when the sod has been applied and stabilized or per the discretion of the Project Manager.

B. Final Acceptance will be defined as a healthy uniform turf over the entire sodded area that does not contain any stressed or bare spots greater than one (1) square foot.

1. Sixty (60) days after sodding, prior to Final Acceptance, the sodded areas shall be reviewed by the Project Manager and the Contractor. Any areas as determined by the Project Manager where the sod has failed to establish shall be re-sodded.

2. The Project Manager shall be satisfied with establishment. The sodded areas shall have a full stand of grass, in a vigorous growing condition, thoroughly rooted to the soil with absence of visible joints.

C. Use approved materials to re-establish turf that does not comply with the requirements of these specifications and continue maintenance until turf meets the requirements and reaches Final Acceptance.

D. After Final Acceptance, the sodded areas will become the responsibility of the City.

PART 16 - MEASUREMENT AND PAYMENT

16.1 MEASUREMENT

A. Measurement will be made by the contract unit specified for Sodding. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

16.2 PAYMENT

A. Payment will be made at the **contract unit** price, and shall include required materials, transportation, equipment, labor, earthwork, loading, transporting, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, temporary protection by fencing or other means, watering and all maintenance required until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 92 23