



City of Thornton
CIP 24-196
BMcD Project No. 154303

2022/2023/2024 Pipeline Rehabilitation

Technical Specifications

SUBMITTAL
ISSUED FOR BID

March 2024



TABLE OF CONTENTS

Technical Specifications and Standard Details City of Thornton – 2022-2024 Pipeline Rehabilitation

Division 00 00 01 07	BID AND CONTRACT DOCUMENTS Index and Certification Page
Division 01	GENERAL REQUIREMENTS <i>Included in Thornton's General and Special Conditions</i>
Division 02 02 41 00	EXISTING CONDITIONS Demolition
Divisions 03 - 08	NOT USED
Division 09 09 90 00	FINISHES Protective Coatings
Divisions 10 – 30	NOT USED
Division 31 31 20 50 31 20 55 31 23 33.13 31 23 33.16	EARTHWORK Site Preparation and Earthwork Sedimentation and Erosion Control Trenching and Backfilling for Utilities Trenching and Backfilling for Utility Structures
Division 32 32 11 23 32 12 16 32 16 00 32 17 23 32 91 05 32 92 00	EXTERIOR IMPROVEMENTS Aggregate Base Courses Asphalt Paving Curbs, Gutters, Sidewalks & Driveways Pavement Markings Topsoiling and Finished Grading Seeding and Sodding
Division 33 33 05 97 33 08 00 33 11 00 33 12 16 33 31 50	UTILITIES Utility Identification Abandonment of Existing Pipelines and Structures Pressure Pipe Utility Valves and Accessories Pipe Installation
Divisions 34 - 48	NOT USED

CLIENT NAME: City of Thornton, Colorado
PROJECT NAME: 2022/2023/2024/2024 Pipeline Rehabilitation
CITY PROJECT NO.: 24 - 196
BMcD PROJECT NO.: 154303

DOCUMENT 00 01 07 – INDEX AND CERTIFICATION PAGE

SPECIFICATION INDEX

<u>DOCUMENT/ DIVISION</u>	<u>DESCRIPTION</u>	<u>NUMBER OF PAGES</u>
00	Bid and Contract Documents	-
02	Existing Conditions	4
09	Finishes	6
31	Earthwork	36
32	Exterior Improvements	38
33	Utilities	24

CERTIFICATION(S)

END OF DOCUMENT 00 01 07

DIVISION 02 – EXISTING CONDITIONS

SECTION 02 41 00 - DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes the removal of existing construction to limits as indicated and specified herein. Demolition includes the complete or partial removal re-use and/or disposal of materials of the following:
 - 1. Soil, vegetation, aggregate, piping, structures, debris, etc.
 - 2. Existing Waterline and appurtenances.
 - 3. Other items as indicated.
- B. Related Work Specified Elsewhere:
 - 1. Section 31 20 50 - "Site Preparation and Earthwork."

1.02 SUBMITTALS:

- A. Schedule of Demolition:
 - 1. Submit as directed by Owner.
 - 2. Submit proposed methods and operations of demolition for review prior to the start of Work. Include in the schedule the coordination for shutoff, capping, and continuation of utility services as required, together with details for dust, noise, and erosion control protection.
 - 3. Provide a detailed sequence of demolition and removal Work to ensure the uninterrupted progress of Owner's operations.

1.03 JOB CONDITIONS:

- A. Owner will be continuously occupying areas immediately adjacent to areas of selective demolition. Conduct selective demolition Work in a manner that will minimize need for disruption of Owner's normal operations. Provide Owner a minimum of seventy-two (72) hours' advance notice of demolition activities which will severely impact Owner's normal operations.
- B. Condition of Structures to be Demolished:
 - 1. Owner assumes no responsibility for actual condition of structures to be demolished.
 - 2. Conditions existing at time of inspection for bidding purposes will be maintained by Owner insofar as practicable. Variations within structure may occur by Owner's removal and salvage operations prior to start of demolition Work.
- C. Protections:
 - 1. Ensure the safe passage of persons around the area of demolition. Conduct operations to prevent injury to adjacent buildings, structures, other facilities, and persons. Erect temporary covered passageways as required by authorities having jurisdiction.
 - 2. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces, and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.

3. Remove protections at completion of Work.
- D. Explosives: The use of explosives will not be permitted.
- E. Traffic:
 1. Conduct demolition operations and the removal of debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.
 2. Do not close, block, or otherwise obstruct streets, walks, or other occupied or used facilities without permission from the Owner. Provide alternate routes around closed or obstructed traffic ways if required by Owner.
- F. Promptly repair damage caused to adjacent facilities by demolition operations at no cost to Owner.
- G. Utility Services:
 1. Maintain existing utilities indicated to remain; keep in service and protect against damage during demolition operations.

PART 2 - PRODUCTS

2.01 SALVAGE OF MATERIALS:

- A. All existing construction and items to be removed shall be considered waste and shall become the property of Contractor. Remove from the Site.

2.02 HANDLING AND STORAGE:

- A. Carefully dismantle Equipment and Materials to be reused or returned to Owner in a manner to avoid damage.
- B. Store Equipment and Materials to be reused in a manner to avoid corrosion, staining, breakage, or damage from any cause.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Prior to commencement of demolition Work, inspect areas in which demolition will be performed. Photograph existing conditions of structures, surfaces, Equipment, or surrounding properties which could be misconstrued as damage resulting from demolition operations. File with Owner prior to starting Work.

3.02 PREPARATION:

- A. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of structures to be demolished and adjacent facilities to remain:
 1. Cease operations and notify Owner and Engineer immediately if safety of structure appears to be endangered. Take precautions to support structure until determination is made for continuing operations.
- B. Locate, identify, stub off, and disconnect utility services that are indicated to remain:
 1. Provide bypass connections as necessary to maintain continuity of service to homes and businesses in the vicinity. Provide minimum of seventy-two (72) hours' advance notice to Owner and homeowner/businessowner if shutdown of service is necessary during changeover.

3.03 DEMOLITION:

- A. Perform demolition in a systematic manner. Use such methods as required to complete demolition indicated on Contract Drawings in accordance with demolition schedule and governing regulations:
 - 1. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.
 - 2. Provide services for effective air and water pollution controls as required by local authorities having jurisdiction.
 - 3. Completely fill below-grade areas and voids resulting from demolition. Provide fill consisting of approved earth, gravel, or sand; free of trash and debris, frost and frozen materials, stones over six-inch (6") diameter, roots, or other organic matter. Use satisfactory soil materials and place as specified in Section 31 20 50 - "Site Preparation and Earthwork."
- B. If unanticipated mechanical, electrical, or structural elements which conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to Owner in written, accurate detail. Pending receipt of directive from Engineer, rearrange demolition schedule as necessary to continue overall job progress without delay.
- C. Pollution Controls:
 - 1. Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.
 - 2. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
 - 3. Clean adjacent structures and areas of dust, dirt, and debris caused by demolition operations.

3.04 DISPOSAL OF DEMOLITION MATERIALS:

- A. Remove debris, rubbish, and other materials resulting from demolition operations.
- B. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.
- C. Burning of removed materials from demolished structures will not be permitted.
- D. Transport materials removed from demolished structures and dispose off the Site at an acceptable and suitable waste site.

3.05 CONNECTIONS TO EXISTING CONSTRUCTION:

- A. Cap, seal, and abandon pipe as indicated.

3.06 CLEANUP AND REPAIR:

- A. Repair demolition performed in excess of that required. Return structures and surfaces that will remain to condition existing prior to commencement of demolition Work. Repair adjacent construction or surfaces soiled or damaged by demolition Work.

END OF SECTION 02 41 00

DIVISION 9 – FINISHES

SECTION 09 90 00 - PROTECTIVE COATINGS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes coating of exterior and interior surfaces throughout the Project, and which are listed in Part 2, with systems specified on "coating system" sheets at the end of this Section.
- B. Coating systems include surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat, and finish coats to be shop-applied, may be specified elsewhere, or referenced to this Section so that a complete system is specified and coordinated.
 - 1. Where surface preparation and first (prime) coat are specified in other Sections to be shop-applied, such as for structural steel, hollow metal doors or equipment, only the touch up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat regardless of if done in shop or field.
 - 2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.
 - 3. Concealed surfaces subject to corrosion or attack if unprotected shall be prime-coated and touched up prior to concealment under insulation or other protective layer.
 - 4. Where Equipment and Materials are provided with shop-applied finished coating system, only touch up coats are a part of field painting.
 - 5. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop-applied.

1.02 RELATED REQUIREMENTS:

- A. Shop Painting and Coatings: All applicable Divisions.
- B. Factory Prefinished Items: All applicable Divisions.

1.03 REFERENCE STANDARDS:

- A. Applicable Standards:
 - 1. American National Standards Institute (ANSI):
 - a. A13.1 - Scheme for the Identification of Piping Systems.
 - b. Z53.1 - Safety Color Code for Marking Physical Hazards.
 - 2. ASTM International (ASTM):
 - a. D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
 - b. D4258 - Surface Cleaning Concrete for Coating.
 - c. D4259 - Abrading Concrete.
 - d. D4260 - Acid Etching Concrete.
 - e. D4261 - Surface Cleaning Concrete Unit Masonry for Coating.
 - 3. Society for Protective Coatings (SSPC) Surface Preparation Specifications:

- a. SP1 - Solvent Cleaning: Removes oil, grease, soil, drawing and cutting compounds, and other soluble contaminants.
- b. SP2 - Hand Tool Cleaning: Remove loose material. Not intended to remove adherent mill scale, rust, and paint.
- c. SP3 - Power Tool Cleaning: Removes loose material. Not intended to remove all scale or rust.
- d. SP5 - White Metal Blast Cleaning: Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
- e. SP6 - Commercial Blast Cleaning: Two-thirds of every 9 inches² free of all visible residues; remainder only light discoloration.
- f. SP7 - Brush-Off Blast Cleaning: Removes only loose material, remaining surface tight and abraded to give anchor pattern.
- g. SP10 - Near-White Blast Cleaning: At least 95% of every 9 inches² shall be free of all visible residues.
- h. SP11 - Power Tool Cleaning to Bare Metal.
- i. SP12 - Surface Preparation and Cleaning of Steel and Other Hard Materials by High and Ultrahigh Pressure Water Jetting Prior to Recoating.
- j. SP13 - Surface Preparation of Concrete.
- 4. National Sanitation Foundation (NSF):
 - a. 61 - Drinking Water Treatment Chemicals - Health Effects.

1.04 SUBMITTALS:

- A. Submit as specified in Thornton's General and Special Conditions
- B. Includes, but not limited to, the following:
 - 1. Schedule of products and paint systems to be used. Schedule shall include the following information:
 - a. Surfaces for system to be applied.
 - b. Surface preparation method and degree of cleanliness.
 - c. Product manufacturer, name, and number.
 - d. Method of application.
 - e. Dry film mil thickness per coat of coating to be applied.
 - 2. Color charts for selection and acceptance.
 - 3. Technical and material safety data sheets.
 - 4. Certification(s) by coating manufacturer(s) that all coatings are suitable for service intended as stated on each coating system sheet. If manufacturer has an equivalent product as that specified, and it is suitable for the intended purpose, Contractor shall submit the recommended product for approval at no increase in cost, and state reasons for substitution.
 - 5. Contractor shall certify in writing to the Engineer/Architect that applicators have previously applied all the systems in this Specification and have the ability and equipment to prepare the surfaces and apply the coatings correctly.
- C. Submittals for industrial maintenance coatings shall be prepared by, or have assistance in preparation of, a corrosion engineer or industrial coatings technical representative of the coating manufacturer.

1.05 QUALITY ASSURANCE (QA):

- A. Include on label of container:

1. Manufacturer's name, product name, and number.
 2. Type of paint and generic name.
 3. Color name and number.
 4. Storage and temperature limits.
 5. Mixing and application instructions, including requirements for precautions which must be taken.
 6. Drying, recoat, or curing time.
- B. A coating report shall be completed daily by Contractor at each phase of the coating system starting with surface preparation. These shall be submitted on the form attached at end of this Section.
- C. In the event a problem occurs with coating system, surface preparation, or application, Contractor shall require coating applicator and coating manufacturer's technical representative to promptly investigate the problem and submit results to Engineer/Architect.
- D. Specified VOC shall mean unthinned maximum VOC certified by manufacturer. VOC content because of thinning shall not exceed that allowed by federal or local environmental regulations.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Delivery of Materials:
1. Deliver in sealed containers with labels and information legible and intact. Containers shall also have correct labels with required information.
 2. Allow sufficient time for testing if required.
- B. Storage of Materials:
1. Store only acceptable materials on Project Site.
 2. Provide separate area and suitable containers for storage of coatings and related coating equipment.
 3. Dispose of used or leftover containers, thinners, rags, brushes, and rollers in accordance with applicable regulations.

1.07 REGULATORY REQUIREMENTS:

- A. In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the United States Environmental Protection Agency (U.S. EPA) and the local and regional jurisdictions. Notify Engineer/Architect of any coating specified herein that fails to conform to the requirements for the location of the Project or location of application.
- B. Lead Content: Use only coatings that are totally lead free.
- C. Chromate Content: Do not use coatings containing zinc-chromate or strontium chromate.
- D. Asbestos Content: Materials shall not contain asbestos.
- E. Mercury Content: Materials shall not contain mercury or mercury compounds.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Proprietary names and product numbers are specified in most systems for material identification from these manufacturers:

1. Ameron Protective Coatings Systems Group, Ameron Corp.
2. Carboline Company, Inc.
3. Ceilcote USA, Inc.
4. Devoe Coating Company, Division of ICI.
5. ITW Devcon Futura Coatings, Inc.
6. International Protective Coatings.
7. Keeler & Long, Inc., Division of PPG Industries, Inc.
8. Pittsburgh Paints, PPG Industries Inc.
9. Sherwin-Williams.
10. Tnemec Company, Inc.
11. Or other approved by Owner and Engineer

2.02 GENERAL:

- A. Materials furnished for each coating system must be compatible to the substrate.
- B. When unprimed surfaces are to be coated, entire coating system shall be by the same coating manufacturer to assure compatibility of coatings.
- C. When shop-painted surfaces are to be coated, ascertain whether finish materials will be compatible with shop coating. Inform Engineer/Architect of any unsuitable substrate or coating conditions.

2.03 COATING SYSTEMS:

- A. Specified on the "Protective Coating System" sheets at the end of this Section.

2.04 SURFACES TO BE COATED:

- A. System A-2.1:
 1. All exposed metal surfaces unless noted otherwise.
- B. System D-1:
 1. Metallic piping lining and coatings as indicated in Contract Specifications.

2.05 SURFACES NOT TO BE COATED:

- A. Factory finished items, PVC pipe or conduit.

2.06 COLOR CODING OF PIPING AND PHYSICAL HAZARDS:

- A. Color Coding of Piping: Exterior and interior by color coding entire pipe.
 1. General:
 - a. Coat piping with solid colors for entire length of pipe in exposed finished and unfinished areas. Exclude areas in pipe chases and furred areas. Color to be selected by Engineer.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

- A. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparation specifications listed.
 1. If grease or oils are present, SSPC SP1 shall precede any other method specified for metal substrates.
 2. Remove surface irregularities such as weld spatter, burrs, or sharp edges prior to specified surface preparation.

- B. Depth of profile will be as specified or as recommended by the manufacturer for each system, but in no instance shall it exceed one-third (1/3) of the total dry film thickness of complete system.
- C. Prepare only those areas which will receive the first coat of the system on the same day.
 - 1. On steel substrates, apply coating before rust bloom forms.
- D. Concrete and masonry surfaces shall be adequately cured prior to coating application.
 - 1. Use surface cleaning methods, followed by mechanical or chemical surface preparation as specified in SSPC SP13.
 - a. Acid etching (ASTM D 4260) shall not be used for vertical surfaces.
 - b. Acid etching shall only be used where:
 - (1) Procedures are in place for removal of acid residues and the handling, containment, and disposal of hazardous materials.
 - (2) Measures for protection of worker health and safety are provided.
- E. For new galvanized steel to be coated, if absence of hexavalent stain inhibitors is not documented, test as described in ASTM D2092, Appendix X2, and remove by one of the methods described therein.

3.02 APPLICATION:

- A. Apply coatings in accordance with coating manufacturer's recommendations.
- B. Use properly designed brushes, rollers, and spray equipment for all applications.
- C. On unprimed surfaces apply first coat of the system the same day as surface preparation.
- D. Dry film thickness of each system shall meet the minimum specified. Maximum dry film thickness shall not exceed the minimum more than twenty percent (20%) or coating manufacturer's requirements if less. Where a dry film thickness range is specified, the range shall not be less than or exceeded.
- E. Shop and field painting shall remain three inches (3") away from unprepared surface of any substrate such as areas to be welded or bolted.
- F. Environmental Conditions:
 - 1. Atmospheric temperature must be 50°F or higher during application, unless otherwise approved by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur within coating recoat cure times.
 - 2. Wind velocities for exterior applications shall be at a minimum to prevent overspray or fallout and not greater than coating manufacturer's limits.
 - 3. Relative humidity must be less than eighty-five percent (85%). The ambient temperature and the temperature of the surface to be painted must be at least 5°F above the dew point.
 - 4. Provide adequate ventilation in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.
- G. Recoat Time: In the event a coating, such as an epoxy, has exceeded its recoat time limit, prepare the applied coating in accordance with manufacturer's recommendations.
- H. Protection:

1. Cover or otherwise protect surfaces not to be painted. Remove protective materials when appropriate.
2. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
3. Provide cover or shields to prevent surface preparation media and coatings from entering orifices in electrical or mechanical Equipment. Where ventilation systems must be kept in operation at time of surface preparation, take precautions to shield intakes and exhausts to prevent the materials from entering system or being dispersed.
4. Provide signs to indicate fresh paint areas.
5. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, and thinners. Dispose of leftover containers, thinners, rags, brushes, and rollers which cannot be reused in accordance with applicable regulations.
6. Do not remove or paint over Equipment data plates, code stamps on piping, or UL fire-rating labels.

3.03 INSPECTION:

- A. Contractor shall provide and use a wet film gauges to check each application approximately every fifteen (15) minutes to immediately correct film thickness under or over that specified.
- B. Contractor shall provide and use a dry film gauge to check each coat mil thickness when dry, and the total system mil thickness when completed.
- C. Use holiday or pinhole detector on systems over metal substrates to detect and correct voids when indicated on system sheet.
- D. Furnish a sling psychrometer and perform periodic checks on both relative humidity and temperature limits.
- E. Check air temperature and temperature of the substrate at regular intervals to be certain surface is 5°F or more above the dew point.

3.04 CLEANING AND REPAIRS:

- A. Remove spilled, dripped, or splattered paint from surfaces.
- B. Touch up and restore damaged finishes to original condition. This includes surface preparation and application of coatings specified.

END OF SECTION 09 90 00

DIVISION 31 - EARTHWORK

SECTION 31 20 50 - SITE PREPARATION AND EARTHWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.02 SUMMARY:

- A. This Section includes:
 1. All subgrade preparation.
 2. Excavating.
 3. Trenching.
 4. Filling.
 5. Embankment construction.
 6. Backfilling including controlled low-strength material (CLSM).
 7. Compacting.
 8. Grading.
 9. Topsoiling.
 10. All related items necessary to complete the Work indicated or specified.

1.03 REFERENCE STANDARDS:

- A. Applicable Standards:
 1. City of Thornton, *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012.
 2. Adams County Standards and Regulations.
 3. ASTM International (ASTM) [Equivalent AASHTO standards may be substituted as approved]:
 - a. C33 - Standard Specification for Concrete Aggregates.
 - b. C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 - c. C94 - Standard Specification for Ready-Mix Concrete.
 - d. C144 - Standards Specification for Aggregate for Masonry Mortar.
 - e. C150 - Standard Specification for Portland Cement.
 - f. C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - g. C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - h. C403 - Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.
 - i. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - j. C939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 - k. C940 - Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.

- l. D75 - Standard Practice for Sampling Aggregates.
- m. D422 - Standard Test Methods for Particle-Size Analysis of Soils.
- n. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort [12,400 ft-lbf/ft³].
- o. D1140 - Standard Test Methods for Determining the Amount of Material in Soils Finer than the No. 200 Sieve in Soils by Washing.
- p. D1241 - Standard Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses.
- q. D1556 - Standard Test Method for Density and Unit Weight of Soil In-place by the Sand Cone Method.
- r. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft³.
- s. D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- t. D2487 - Standard Practice for Classification of Soils for Engineering Purposes [Unified Soil Classification System].
- u. D3776 REV A - Standard Test Methods for Mass per Unit Area [Weight] of Fabric.
- v. D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
- w. D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
- x. D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- y. D4546 - Standard Test Methods for One-Dimensional Swell or Collapse of Soils.
- z. D4632 REV A - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
- aa. D4751 - Standard Test Method for Determining the Apparent Opening Size of a Geotextile.
- bb. D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
- cc. D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
- dd. D5084 - Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
- ee. D5239 - Standard Practice for Characterizing Fly Ash for use in Soil Stabilization.
- ff. D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- 4. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR Part 1926 - Safety and Health Regulations for Construction.
- 5. State of Colorado Standard Specifications for Road and Bridge Construction.

1.04 SUBMITTALS:

- A. Submit as specified in Thornton's General and Special Conditions.
- B. Includes, but not limited to, the following:
 - 1. Test results from laboratory testing of proposed borrow material.

2. Test results from laboratory testing of granular material and trench stabilization material.
 3. Test results from laboratory testing of CLSM.
 4. Erosion Protection and Sediment Control Plan (EPSCP).
 5. Dewatering plan.
 6. Sheet piling and shoring excavation plan.
- C. Where selecting an option for excavation, trenching, and shoring in compliance with local, state, or federal safety regulations such as OSHA 29 CFR Part 1926 or successor regulations, which require design by a registered Professional Engineer, submit (for information only and not for Engineer approval) the following:
1. Copies of design calculations and notes for sloping, benching, support systems, shield systems, and other protective systems prepared by or under the supervision of a Professional Engineer (P.E.) legally authorized to practice in the jurisdiction where the Project is located.
 2. Documents provided with evidence of registered Professional Engineer's seal, signature, and date in accordance with appropriate state licensing requirements.

1.05 QUALITY CONTROL (QC):

- A. Sampling and Testing:
1. Quality Control (QC) to be performed by Contractor using an independent and certified testing agency.

1.06 PROJECT CONDITIONS:

- A. Lines and grades shall be as indicated. Use City control points as indicated on Contract Drawings.
- B. Carefully maintain all benchmarks, monuments, and other reference points and replace per Colorado Law as directed by City Surveyor if disturbed or destroyed.
- C. Disposition of Utilities:
1. Existing underground utilities are shown on Contract Drawings using the best information available at the time of Drawing preparation. Contractor shall identify, locate, and protect all underground utilities which may be affected by construction under this Contract before starting excavation or other Site construction activities which could damage existing utilities.
 2. Remove or relocate only as indicated, specified, or directed. Provide a minimum forty-eight (48) hours' notice to Engineer and receive written notice to proceed before interrupting any utility service.
 3. Adequately protect from damage all active utilities and remove or relocate only as indicated or approved.
 4. Report active, inactive, and abandoned utilities encountered in excavating and grading operations that are not indicated on Contract Drawings. Remove, plug, or cap as directed by Engineer.
 5. Provide as-constructed Drawings of underground facilities either not shown or found at locations that differ from those shown on Contract Drawings.
- D. Survey Work, to accurately determine locations, elevations, and quantities of Contract pay items, shall be performed during construction by Professional Surveyor registered in the state of Colorado. Surveyor shall be retained and compensated by Contractor. Contractor shall notify Engineer prior to commencing survey work.

PART 2 - PRODUCTS

2.01 MATERIALS ENCOUNTERED:

- A. **Suitable Materials:** Materials suitable for use in embankment and fill include material that is free of debris, roots, organic matter, frozen matter, and which is free of stone having any dimension greater than two inches (2") in areas requiring a high degree of compaction, or three inches (3") in other embankment and fill areas:
1. Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands generally exclusive of clayey and silty material with the following properties:
 - a. Are free-draining.
 - b. Impact compaction will not produce a well-defined moisture-density relationship curve.
 - c. Maximum density by impact methods will generally be less than by vibratory methods.
 - d. Generally less than fifteen percent (15%) by dry weight of soil particles pass a No. 200 square-mesh sieve.
 2. Cohesive materials include materials made up predominately of silts and clays generally exclusive of sands and gravel with the following properties:
 - a. Impact compaction will produce a well-defined, moisture-density relationship curve.
 - b. Are not free draining.
- B. **Unsuitable Materials:** Materials unsuitable for use in embankment and fill include all material that contains debris, roots, organic matter, frozen matter, shale particles, or material containing gravel or stone with any dimension greater than two inches (2") in areas requiring a high degree of compaction or three inches (3") in other embankment and fill areas, or other materials that are determined by Engineer as too wet or otherwise unsuitable for providing a stable subgrade or stable foundation for structures.
- C. **Material used for embankment or fill:**
1. For soils used below structural elements, such as footings, slabs, pavements, and mats, that portion of material passing the No. 40 square-mesh sieve shall have a liquid limit not exceeding thirty (30) and a plasticity index not exceeding twenty (20) when tested in accordance with ASTM D4318.
- D. All Materials encountered, regardless of type, character composition and condition thereof, shall be considered "unclassified" for the purpose of payment. Determine quantity of various materials to be excavated prior to submitting Bid. Rock encountered shall be handled at no extra cost to Owner.
- E. **Waste Materials:**
1. Waste materials, as described for purposes of this Section, consist of unsuitable materials, excess suitable material, rock, demolition debris, and other materials considered unacceptable for use as fill, and which are not environmentally contaminated. Waste materials shall not include environmental pollutants, hazardous substances, contaminated products, by-products, samples, or waste materials of any kind that are regulated under environmental laws.
 2. Dispose of waste materials in accordance with Paragraph 3.03G.

2.02 BORROW MATERIALS:

- A. Suitable fill materials, granular materials, and topsoil obtained from locations arranged for by Contractor (off the Site). Required to the extent sufficient suitable materials are not obtained from excavation and trenching.
- B. Obtain, excavate, haul, handle, place, and compact borrow materials.
- C. Borrow materials shall not exhibit characteristics of high shrink-swell potential as determined from Atterberg limit tests ASTM D4318 and/or swell tests ASTM D4546 unless otherwise specified herein.

2.03 EMBANKMENT AND FILL MATERIAL:

- A. Contractor to coordinate with Owner regarding available embankment material at Mount McKay.
- B. Material shall be free of roots or other organic matter, refuse, ashes, cinders, frozen earth, or other unsuitable material.
- C. Use suitable material sufficiently friable for embankment to provide a dense mass free of voids and capable of satisfactory compaction.
- D. Do not use material containing gravel, stones, or shale particles greater in dimension than one-half the depth of the layer or lift to be compacted.
- E. Moisture content shall be that required to obtain specified compaction of the soil or as indicated.
- F. Perform moisture curing by wetting or drying of the material as required to attain required compaction criteria.
- G. Each lift of the embankment material shall not exceed eight inches (8") in loose depth, as per City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012.

PART 3 - EXECUTION

3.01 SITE PREPARATION:

- A. Clearing and Grubbing:
 - 1. Perform only in areas where earthwork or other construction operations are to be performed.
 - 2. Protect tops, trunks, and roots of existing trees which are to remain on Site.
 - 3. Clear areas and dispose of other trees, brush, and vegetation before starting construction.
 - 4. Remove tree stumps and roots larger than three inches (3") in diameter and backfill resulting excavations with compacted, suitable material.
 - 5. Dispose of debris from clearing and grubbing and demolition at a location off the Site, as arranged for by Contractor, at no additional cost to Owner.
 - 6. Contractor may claim and salvage any timber or other debris which may be considered of value but shall not delay in any manner either this Contract or other work with salvaging operations.
- B. Stripping:
 - 1. Remove topsoil from all areas within limits of the construction easement which are to be used for any purpose except for stockpiling excavated materials as follows:
 - a. Scrape areas clean of all brush, grass, weeds, roots, and other material.

2. Strip to depth of approximately six inches (6") or to a sufficient depth to remove excessive roots in heavy vegetation or brush areas and as required to segregate topsoil, or as directed by Engineer.
 3. Stockpile topsoil in areas where it will not interfere with construction operations or existing facilities. Stockpiled topsoil shall be reasonably free of subsoil, debris, and stones larger than two inches (2") in diameter.
 4. Remove waste from the Site.
- C. Protection of Trees:
1. Protect tops, trunks, and roots of existing trees on Project Site which are to remain, as follows:
 - a. Box, fence around, or otherwise protect trees before any construction Work is started.
 - b. Do not permit heavy equipment or stockpiles within branch spread.
 - c. Trim or prune to obtain working space in lieu of complete removal when possible. Conduct operation as follows:
 - (1) By a certified Arborist.
 - (2) Conform with good horticultural practice.
 - (3) Preserve natural shape and character.
 - (4) Protect cuts with approved tree paint.
 - d. Grade around trees as follows:
 - (1) Trenching: Where trenching is required around trees which are to remain, avoid cutting the tree roots by careful hand tunneling under or around the roots. Avoid injury to or prolonged exposure of roots.
 - (2) Raising Grades: Where existing grade at a tree is below the new finished grade and fill not exceeding 16 inches is required, place 1 to 2 inches of clean, washed gravel directly around the tree trunk. Extend gravel out from trunk on all sides at least 18 inches and finish 2 inches above finished grade at tree. Install gravel before earth fill is placed. Do not leave new earth fill in contact with any tree trunks.
 - (3) Lowering Grades: Regrade by hand to elevation required around existing trees in areas where new finished grade is to be lower. As required, cut the roots cleanly 3 inches below finished grade, and cover scars with tree paint.
 - e. Remove when damage occurs and survival is doubtful.
 - f. Replace with similar item when damaged through carelessness and so requested.
 - g. Unless otherwise approved by the property Owner, all trees along the pipeline alignments are to be maintained.

D.

3.02 DEMOLITION:

- A. Remove existing structures and improvements as required (as indicated) to perform new construction.
- B. Carefully dismantle, in a manner to avoid damage, all materials and equipment indicated to be relocated or returned to Owner.
- C. Material or equipment specified or indicated to be relocated or returned to Owner that is damaged due to Contractor's negligence shall be repaired or replaced, as determined by Engineer, at no additional cost to Owner.

- D. Materials not indicated or specified to be relocated or returned to Owner shall become property of Contractor and be disposed of as specified in "Waste Materials," this Part.
- E. Perform demolition work to protect existing facilities, structures, and property which are to remain, against damage from operations, falling debris, or other cause.
- F. Make provisions for temporarily accommodating flows in existing facilities that are to be relocated or disturbed.
- G. Take precautions to guard against movement or settlement and provide shoring and bracing as necessary.
- H. If at any time safety of existing structure to remain is endangered, cease operations, notify Engineer, and do not resume operations prior to approval.
- I. Remove concrete by jack hammering, sawing, core drilling, or other approved method.
- J. Remove existing pavement by jack hammering, sawing, scarifying, or other approved methods except as follows:
 - 1. Existing asphaltic or Portland cement concrete pavement shall be sawed at point where pavement indicated to remain ends and pavement indicated to be removed begins.
 - 2. Existing Portland cement concrete pavement shall be removed back to the nearest joint unless otherwise indicated or approved by Engineer.

3.03 EXCAVATION AND TRENCHING:

- A. Sheeting and Bracing:
 - 1. Design, furnish, place, maintain, and subsequently remove, to extent required, a system of temporary supports for cut and cover, open cut, or trench excavations, including bracing, dewatering, and associated items to support sides and ends of excavations where excavation slopes might endanger in-place or proposed improvements, extend beyond construction rights-of-way (ROW), or as otherwise specified or indicated.
 - 2. Provide all materials on Site prior to start of excavation in each section and make such adjustments as are required to meet unexpected conditions.
 - 3. Space and arrange sheeting and bracing as required to exclude adjacent material and according to stability of excavation slopes.
 - 4. Assess existing conditions including adjacent property and possible effects of proposed temporary works and construction methods, and select and design such support systems, methods, and details as will control safety to the public, adjacent property, and the completed Work.
 - 5. Modify or relocate underground facilities, at no additional cost to Owner, if existing underground facilities interfere with Contractor's proposed method of support.
 - 6. Use caution in areas of underground facilities, which shall be exposed by hand or other excavation methods acceptable to Owner.
 - 7. Perform sheeting, shoring, and bracing in accordance with safety and protection requirements of the Contract Documents.
 - 8. Provide sheeting, shoring, and bracing for trench excavation in subgrade of excavation when required to prevent movement of the main excavation support system.

9. Provide shoring, sheeting, and bracing as indicated or as needed to meet the following requirements:
 - a. Prevent undermining and damage to all structures, buildings, underground facilities, pavements, and slabs.
 - b. Perform excavations with vertical banks where necessary for construction activities or as indicated, and within all limits of excavation noted on Contract Drawings.
 - c. Design excavation support system and components to support lateral earth pressures, unrelieved hydrostatic pressures, utility loads, traffic and construction loads, and building and other surcharge loads to allow safe and expeditious construction of permanent structures without movement or settlement of the ground, and to prevent damage to or movement of adjacent buildings, structures, underground facilities, and other improvements. Design shall account for staged removal of bracing to suit the sequence of concrete placement for permanent structures and backfill.
 - d. Except as otherwise specified herein, shoring and sheeting materials may be extracted and reused at Contractor's option; however, Contractor shall remove and replace any existing structure or underground facility damaged during shoring and sheeting. Remove sheeting and bracing as backfill progresses. Fill voids left after withdrawal with sand or other material approved by Engineer.
 - e. Where shoring and sheeting materials must be left in place in the completed Work to prevent settlements to or damage within adjacent structures or as directed by Engineer, backfill the excavation to three feet (3') below finished grade and remove the remaining exposed portion of shoring before completing backfill. If soldier piles and wood lagging are used for shoring, remove wood lagging to within three feet (3') of finished grade in incremental steps of approximately six inches (6") as backfill is placed, or to Contractor's design if more stringent. Location of all shoring and sheeting left in-place shall be documented on Contractor-furnished construction record Drawings and provided to Engineer and Owner.
10. Contractor shall engage a registered professional engineer (P.E.) in the state of Colorado to design all shoring, sheeting and bracing, permanent or temporary to be used on the Project. Submit calculations to engineer for approval prior to start work. Contractor shall be solely responsible for proper design, installation, operation, maintenance, and any failure of any component of the system. Review by Engineer of Drawings and data submitted by Contractor shall not in any way be considered to relieve Contractor from full responsibility for errors therein or from the entire responsibility for complete and adequate design and performance of the sheeting and shoring system.
11. Provision for Contingencies:
 - a. Performance of components of the support system shall be monitored for both vertical and horizontal movement daily.
 - b. Provide a contingency plan or alternative procedure for implementation if system does not adequately perform.

- c. Keep materials and equipment necessary to implement the contingency plan readily available.
- 12. Damages:
 - a. Document all existing damage to adjacent facilities and submit information to Owner prior to performing any excavation. Documentation shall include a written description, diagrams, measurements, and appropriate photographs.
 - b. Repair all damage resulting from Contractor's excavation and remove and replace all undermined pavements with Owner-approved equal, either concrete or asphalt, at no expense to Owner.
- B. Explosives: Blasting will not be permitted.
- C. Excavation for Structures:
 - 1. Excavate area adequate to permit efficient erection and removal of forms.
 - 2. Trim to neat lines where details call for concrete to be deposited against earth.
 - 3. Excavate by hand in areas where space and access will not permit use of machines.
 - 4. Notify Engineer immediately when excavation has reached the depth indicated.
 - 5. Overexcavate and replace any localized zones of excessively wet, unstable, organic, yielding, or low bearing capacity materials as directed by Engineer. Restore bottom of excavation to proper elevation with compacted trench stabilization material in areas overexcavated. Correct at no additional cost to Owner when overexcavated without authority or to stabilize bottom rendered unsuitable through negligence or improper dewatering or other operations.
- D. Trenching for Underground Utilities:
 - 1. Side Walls:
 - a. Make vertical or sloped within specified trench width limitations below a plane twelve inches (12") above top of pipe.
 - b. Make vertical or sloped as required for stability, above a plane twelve inches (12") above top of pipe.
 - c. Excavate without undercutting sidewalls.
 - 2. Trench Depth:
 - a. Excavate to depth sufficient to provide the minimum bedding requirements for the pipe being placed.
 - b. Do not exceed that indicated where conditions of bottom are satisfactory.
 - c. Increase depth as necessary to remove unsuitable supporting materials.
 - d. Maintain a minimum of three feet (3') of soil cover above top of pipe.
 - 3. Trench Bottom:
 - a. Protect and maintain when suitable natural materials are encountered.
 - b. Remove rock fragments and materials disturbed during excavation or unraveled from trench walls.
 - c. Restore to proper subgrade with trench stabilization material when overexcavated.
 - 4. Trench Width:
 - a. Excavate trench to a width which will permit satisfactory jointing of pipe and thorough tamping of bedding and backfill.
 - b. Do not exceed following trench widths:

- (1) For single pipe installation, maintain trench widths below a plane twelve inches (12") above top of pipe as follows:

Trench Width		
Nominal Pipe Size	Minimum	Maximum
Less than 24 inches	Pipe O.D. + 1 foot	Pipe O.D. + 2 foot

- c. For multiple pipe installations maintain trench widths below a plane twelve inches (12") above the top of the largest pipe as follows:

Trench Clearances		
Nominal Pipe Size	Minimum from Outside Pipe (in)	Maximum from Outside Pipe (in)
Less than 24 inches	6	12

- (1) Above plane defined in (1) and (2), no maximum limit.
 - (2) Maximum trench width limitations shall apply in all areas more than three feet (3') from manhole or structure walls.
 - (3) Maximum width shall be as near the minimum specified as can be controlled by construction equipment and methods used.
5. Fill and Embankment Areas: Perform trenching only after compacted fill or embankments have reached an elevation of not less than one foot (1') above top of pipe.
 6. Limit maximum length of open trench to one hundred feet (100') in advance and to fifty feet (50') behind pipe installation.
 7. Test Pits:
 - a. Excavate test pits sufficiently in advance of trenching to enable adequate planning of construction procedure.
 - b. Locate as follows:
 - (1) When unstable material is suspected that may require special protective measures.
 - (2) Where groundwater may require special handling methods.
 - (3) Where indicated or otherwise approved.
 - (4) Where interference or conflict with other utilities or structures could affect alignment of pipe.
 - c. To depth required to obtain information desired.
- E. Dewatering:
1. Control grading around excavations to prevent surface water from flowing into excavation areas.
 2. Drain or pump as required to continually maintain, including days not normally worked, all excavations free of water or mud from any source, and discharge to approved drains or channels. Commence when water first appears and continue as required to keep excavation free of standing water during entire time excavation is open.
 3. Use pumps of adequate capacity to ensure rapid drainage of area, and construct and use drainage channels and subdrains with sumps required.
 4. When water is found in excavation due to Contractor negligence, remove unsuitable excessively wet subgrade materials and replace with approved trench stabilization material as directed by Engineer and at no additional cost to Owner.

5. Refer to Section 105.4-N in the City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012.
6. General:
 - a. Design and provide a dewatering system using accepted and professional methods of design and engineering consistent with the best current practice to eliminate water entering excavation under hydrostatic head from bottom and/or sides.
 - (1) Design system to prevent differential hydrostatic head because of rising water levels from adjoining or nearby bodies of water, proximity of excavation to phreatic groundwater level, or surface runoff, resulting in a "quick" or "boiling" condition.
 - (2) System shall not be dependent solely upon sumps and/or pumping water from within excavation where differential head would result in a "quick" condition and continue to worsen the excavation's stability.
 - b. Provide dewatering system of a sufficient size and capacity as required to control ground and surface water flow into excavation and to allow all Work to be installed in a dry condition, including the obtaining of a licensed well-driller, where required.
 - c. Control, by acceptable means, all water regardless of source and be fully responsible for disposal of water.
 - d. Confine all discharge piping and/or ditches to available easement or to additional easement obtained by Contractor. Provide all necessary means for disposal of water, including the obtaining of all necessary permits and of additional easement at no additional cost to Owner.
 - e. Control groundwater in a manner that preserves strength of foundation soils, does not cause instability or unraveling of excavation slopes, and does not result in damage to existing structures.
 - (1) Where necessary to these purposes, lower water level in advance of excavation, using wells, wellpoints, jet eductors, or similar positive methods.
 - (2) Water level as measured in piezometers shall be maintained a minimum of three feet (3') below the prevailing excavation level.
 - f. Provide means for positive dewatering of all water sources prior to any appearance of water in excavation and continue until Work is complete to the extent that no damage results from hydrostatic pressure, flotation, or other causes.
 - g. Open pumping with sumps and ditches shall be allowed, provided it does not result in boils, loss of fines, softening of the ground, or instability of slopes.
 - h. Install wells and/or wellpoints, if required, with suitable screens and filters, so that continuous pumping of fines does not occur. Arrange the discharge to facilitate collection of samples by Owner. During normal pumping, and upon development of well(s), levels of fine sand or silt in discharge water shall not exceed five parts per million (5 ppm). Install a sand tester on discharge of each pump during testing to verify that levels are not exceeded.

- i. Install, operate, and maintain dewatering system required to control surface and/or groundwater.
 - j. Control grading around excavations to prevent surface water from flowing into excavation areas.
 - k. Drain or pump as required to continuously maintain all excavations and trenches free of water or mud from any source, and discharge to approved drains or drainage channels. Commence when water first appears and continue until Work is complete to the extent that no damage will result from hydrostatic pressure, flotation, buoyancy, or other causes.
 - l. No additional payment will be made for any supplemental measures to control seepage, groundwater, or artesian head.
7. Design:
- a. Designate and obtain services of a qualified dewatering specialist or expert to provide a dewatering plan as may be necessary to complete the Work. Provide dewatering plan at time of Bid submission. Plan items shall include, but not be limited to, the following:
 - (1) Drawings indicating general location and size of berms, dikes, ditches, all deep wells, observation piezometer wells, wellpoints, jet eductors, sumps, and discharge lines, including their relation to water disposal ditches.
 - (2) Make, model, and capacities of pumps, prime movers, power generators, and standby equipment.
 - (3) Design calculations, including any computer modeling, to show adequacy of system and selected equipment, estimated flow rate of water to be discharged, and estimated duration for groundwater to be drawn down to elevations required for excavation.
 - (4) Detailed description of dewatering procedure and maintenance method.
 - (5) Description of emergency plan to protect in-place construction during an unanticipated rise in groundwater due to loss of power or other unexpected conditions or inundation from surface water.
 - (6) Additional details, as requested by Engineer.
 - (7) Specific items to be included addressing dewatering operations using wells, wellpoints, or jet eductors shall consist of the following:
 - (a) Diameter of hole drilled.
 - (b) Type of equipment and method of well installation.
 - (c) Diameter and material type of well casing inserted.
 - (d) Elevation of top of each well.
 - (e) Screen opening sizes.
 - (f) Screened interval or elevations of segments in well that are screened.
 - (g) Backfill gravel pack zone elevations.
 - (h) Gravel pack gradation.
 - (i) Size of pumps (horsepower).
 - (j) Anticipated pumping capacity (gallons per minute).
 - (k) Drawdown in well with time during pumping.
 - (l) Drawdown in piezometers with time during pumping.
 - (m) Number and location of wells.

- (n) Number and location of piezometers.
 - (o) Wellpoint details.
 - (p) Certification license of well-driller, where required.
 - b. In preparing dewatering plan, consider all available information, together with Site constraints, excavation/sheeting requirements, and construction schedule. Other potential problems may require specific reference and amplification within dewatering plan.
 - c. After completion of dewatering installation and prior to commencement of excavation, submit to Owner and Engineer for review a detailed plan of dewatering system as constructed, together with test data and computations demonstrating that the system can achieve specified results.
 - d. Contractor shall be solely responsible for proper design, installation, operation, maintenance, and any failure of any component of system. Notice to Proceed (NTP) issued by Owner or submittal of dewatering plans and data by Contractor shall not relieve Contractor from full responsibility for errors therein or for complete and adequate design and performance of system in controlling water level in excavated areas and for control of hydrostatic pressures to depths specified.
 - e. Contractor shall be responsible for accuracy of Drawings, design data, and operational records required by this Section.
 - f. Piezometers and Groundwater Monitoring:
 - (1) Install as a minimum three (3) piezometers, in addition to any required by regulating agencies having jurisdiction, at locations prior to excavation below the groundwater level for purpose of monitoring groundwater elevations in vicinity of excavation. Design and location of piezometers will be subject to review by Engineer.
 - (2) Observe and record twice daily the elevation of groundwater in all piezometers daily seven (7) days a week and furnish a daily written summary of observations to the City of Thornton's Construction Coordinator. Record groundwater elevations to nearest 0.1 feet (0.1'), with observations conducted throughout duration of any dewatering, and until dewatering is no longer required.
 - (3) Monitor upstream and downstream river/stream levels to anticipate rising groundwater levels.
 - (4) Repair or replace within twenty-four (24) hours piezometers that become inactive, damaged, or destroyed. If required, suspend excavation and construction activities in areas where piezometers are not functioning properly until reliable observations can be made. Add or remove water from piezometer risers and demonstrate that piezometers are functioning properly.
 - (5) Remove and grout piezometers when dewatering is completed, and in accordance with jurisdictional agencies.
- 8. Damages:
 - a. Repair without additional cost to Owner any damage to Work in-place, other contractors' equipment, utilities, residences, highways, roads, railroads, private and municipal well systems, adjacent structures, and the excavation, including damage to the bottom due to heave and including but not limited to, removal and pumping out of the excavated

- area that may result from Contractor's negligence, inadequate or improper design and operation of dewatering system, and any mechanical or electrical failure of dewatering system.
- b. Remove subgrade materials rendered unsuitable by excessive wetting and replace with approved backfill material at no additional cost to Owner.
9. Maintaining Excavation in Dewatered Condition:
- a. Dewatering shall be a continuous operation. Interruptions due to power outages, or any other reason shall not be permitted.
 - b. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until critical period of construction and/or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation, or other hydrostatic pressure imbalance.
 - c. Provide standby equipment on Site, installed, wired, and available, for immediate operation if required to maintain dewatering on a continuous basis in event any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, perform such work as may be required to restore damaged structures and foundation soils at no additional cost to Owner.
 - d. Subsequent to completion of excavation and during installation of all Work in the excavated area, maintain the excavation in a dewatered condition.
 - e. System maintenance shall include but not be limited to 24-hour supervision by personnel skilled in the operation, maintenance, and replacement of system components, and any other work required to maintain the excavation in a dewatered condition.
10. System Removal:
- a. Remove all dewatering equipment from Site, including related temporary electrical service.
 - b. All wells shall be removed or cut off a minimum of three feet (3') below the final ground surface, capped, and abandoned in accordance with regulations by agencies having jurisdiction.
 - c. Removal work required under this Paragraph does not include any Site cleanup work as required elsewhere in these Specifications.
11. River/Stream Crossings:
- a. River/Stream crossings exist as indicated along this Project, requiring excavation below potential stream or river phreatic levels. Dewatering methods shall incorporate means to account for rising or varying water levels associated with these bodies of water and their interconnected waterways, whether surface or subsurface, to prevent threatening integrity of the excavation, existing facilities, and Work under construction.
 - b. Conform to applicable requirements in all related Sections.
 - c. Maintain area drainage during construction.
 - d. Complete channel protection expeditiously following excavation.
- F. Waste Materials:

1. Remove unsuitable materials from Work area as excavated.
2. Deposit such materials in locations and within areas indicated or designated by Engineer.
3. Material shall become property of Contractor and shall be disposed of off-site at locations arranged for by Contractor.
4. Segregate excess suitable materials and topsoil from unsuitable materials for possible use by others. Place excavated rock in interior of waste area fills so it will not be exposed to view.
5. Grade waste areas and leave free-draining with an orderly, neat appearance. Side slopes shall not be steeper than three horizontal to one vertical (3:1). Topsoil, seed, and mulch waste areas.

3.04 EARTHWORK:

A. Subgrades:

1. General:
 - a. Excavate or backfill as required to construct subgrades to elevations and grades indicated.
 - b. Remove all unsuitable material and replace with acceptable fill material and perform all wetting, drying, shaping, and compacting required to prepare subgrade.
 - c. Proofrolling: Exposed area to receive fill, backfill, or embankment shall be proofrolled to detect localized zones of excessively wet, unstable, organic, or low bearing capacity materials as follows:
 - (1) Proofroll as a single-pass operation with conventional compaction equipment during subgrade preparation and prior to placement of fill, and as a spot check process without the need for complete coverage per unit area of tire. Soft spots shall be overexcavated, backfilled, and compacted with suitable material.
 - (2) Proofroll within limits of proposed construction of footings, slabs, mats, or pavement and to extent of 10 ft. beyond proposed exterior walls and stated limits, or as otherwise noted. Proofroll with loaded dump truck, loaded pan scrapper, 15-ton light class pneumatic tired roller compactor, or equivalent. Ground contact pressure of 80 psi and average speed of 5 miles (8 km) per hour shall be maintained and continue until extent of soft spots is determined with not less than one pass per unit area of tire. Soft spots shall be overexcavated, backfilled, and compacted with suitable material.
2. Subgrade for Fills and Embankments: Roughen by discing or scarifying and wet or dry top six inches (6") as required to bond with fill or embankment.
3. Subgrade for Roadways, Drives, Parking Areas:
 - a. Extend subgrade the full width of pavement or base course, plus one foot (1') in each direction.
 - b. Cohesive Soil Subgrades: Compact the top six inches (6") of subgrade for traffic areas and railroads in embankment or excavation to a minimum of ninety-five percent (95%) of maximum dry density within the moisture content range from one percent (1%) below optimum to three percent (3%) above optimum. Optimum moisture and maximum dry density shall be determined by ASTM D698.

- c. Cohesionless Soil Subgrades: Compact the top six inches (6") of subgrade for traffic areas and railroads in embankment or excavation to not less than ninety-five percent (95%) of relative dry density as determined by ASTM Methods D4253 and D4254.
- B. Embankments and Fills:
 1. Construct embankments to contours and elevations indicated, using suitable approved material from excavations and borrow areas:
 - a. Place fill material in maximum 8-inch loose lifts.
 - b. Place embankment only on subgrades approved by Engineer.
 - c. Do not place snow, ice, or frozen earth in fill; do not place fill on a frozen surface.
 2. Obtain compaction by the controlled movement of compaction equipment approved by Engineer during placing and grading of layers and to minimum density specified for indicated locations.
 3. Except as indicated or specified otherwise, compact cohesive soils to a minimum of ninety-five percent (95%) of maximum dry density within the moisture content range from one percent (1%) below optimum to three percent (3%) above optimum. Optimum moisture and maximum dry density shall be as determined by ASTM D698.
 4. In areas of fill supporting structures or under paved areas, compact cohesive soils to a minimum of ninety-eight percent (98%) of maximum dry density within the moisture content range from one percent (1%) below optimum to three percent (3%) above optimum. Optimum moisture and maximum dry density shall be as determined by ASTM D698.
 5. Except as indicated or specified otherwise, compact cohesionless soils to not less than seventy-five percent (95%) relative density as determined by ASTM Method D4253 and D4254.
- C. Pipe Embedment:
 1. Pipe bedding shall be as indicated, using granular material.
 2. Place granular embedment as follows:
 - a. With level bottom layer at proper grade to receive and uniformly support pipe barrel throughout its length.
 - b. Form shallow depression under each joint to facilitate jointing.
 - c. Form depression under each joint so that no part of bell or coupling is in contact with trench when pipe is placed in position.
 - d. Add second layer simultaneously to both sides of pipe with care to avoid displacement.
 - e. Complete promptly after completion of jointing operations.
 - f. Substitute for any part of earth backfill to within two feet (2') of final grade at Contractor's option.
 3. Compact granular embedment as follows:
 - a. In loose lifts not exceeding twelve inches (12") in depth.
 - b. Rod, spade, or use pneumatic or vibratory equipment:
 - (1) As required to obtain not less than seventy-five percent (75%) relative density as determined by ASTM D4253 and D4254.
 - (2) Throughout depth of embedment.
 - c. Compaction using flooding or water spraying techniques will not be allowed.

4. CLSM embedment shall be as indicated and shall be used at impervious trench checks. Shape trench bottom to fit pipe and backfill throughout depth of trench with CLSM.
- D. Backfilling:
1. Backfill for structures and trenches shall be as specified in "Embankments and Fills," this Section, with the following additional provisions:
 2. Structures:
 - a. Backfill only after concrete has attained seventy percent (70%) design strength.
 - b. Backfill adjacent to structures only after a sufficient portion of structure has been built to resist imposed load.
 - c. Remove all debris from excavation prior to placement of material.
 - d. Place backfill in level loose lifts of thickness within compacting ability of equipment used but not to exceed eight inches (8") in thickness.
 - e. Perform backfilling simultaneously on all sides of structures.
 - f. Exercise extreme care in use of heavy equipment in areas adjacent to structures. Equipment operated within ten feet (10') of any wall shall not exceed 20,000 pounds (20,000 lb) gross weight.
 - g. Material above a 45-degree (45°) plane intersecting the footing shall not include rock fragments incapable of passing a 6-inch screen, and no shale whether disintegrated or not.
 3. Trenches:
 - a. Backfill for trenches shall be as specified for structures and as follows:
 - (1) Complete promptly upon completion of pipe embedment and approval to proceed.
 - (2) Use hand methods to a plane twelve inches (12") above top of pipe.
 - (3) Mechanical methods shall be acceptable where hand backfill is not required.
 - (4) Backfill in lifts of thickness within compacting ability of equipment used, but not greater than eight inches (8").
 - (5) Until compacted depth over conduit exceeds three feet (3'), do not drop fill material over five feet (5'). Distance may then be increased two feet (2') for each additional one foot (1') of cover.
 4. Controlled Low-Strength Material (CLSM):
 - a. Place CLSM by means of chute, drop pipe, pump, bucket, or other method approved by Engineer to maintain consistency, flowability, and strength of in-place final product. Fill all voids and place to indicated grades or minimum elevations noted without use of a vibrator.
 - b. Open ends of area to be backfilled shall be plugged or built-up with a temporary bulkhead arrangement to prevent loss of CLSM during placement or during curing.
 - c. Prevent movement of any adjacent structure or pipe conduit:
 - (1) Anchor pipe or structure to prevent uplift or movement prior to placement of CLSM.
 - (2) Prevent intrusion of CLSM into interior sections of structure or pipe.
 - (3) If any such movement or intrusion occurs, affected structures or pipe shall be cleaned and may require excavation, removal, and replacement of CLSM to intended final fill elevation, as determined by Engineer or Owner, and at no additional cost to Owner.

- d. CLSM is intended for placement within a hole that is dry or maintained with a positive dewatering operation. If it is necessary to place CLSM under water, method for placement and mix design shall be submitted to Engineer for approval at least ten (10) working days prior to any intended pours.
 - e. Monitor surface elevation of placed CLSM and document any shrinkage or settlement of initial placement volume. Provide information of shrinkage and/or settlement of initial lift to Engineer prior to placement of any additional layers or completion of CLSM placement to final indicated elevation.
 - f. CSLM shall not be covered with soil or other imposed loading until a minimum compressive strength of 30 psi is attained or until a minimum of twelve (12) hours of cure time has elapsed whichever comes first. Minimum strengths shall be demonstrated by laboratory test results or if permitted by Engineer, by failure to deform or crush the fill with an equivalent 30 psi applied loading in the field.
 - g. Protect CSLM from freezing while curing with insulated blankets or other approved methods.
 - h. Where air may become trapped under slabs due to grade beams or other structural components, holes shall be drilled at locations indicated, or as directed by Engineer to allow for uniform placement of CLSM entirely within the void region. Plugs shall be installed to confine CLSM, as needed. It is not intended that raising or leveling of any slabs or structural elements shall occur from placement methods.
- E. Site Grading:
- 1. Excavate, fill, compact fill, and rough grade to bring Project Site outside buildings to subgrades as follows:
 - a. For surfaced areas, to underside of respective surfacing or base course.
 - b. For areas to receive topsoil, to a minimum of four inches (4") below finished grade.
 - c. When rock is encountered in grading areas outside buildings, overexcavate to depth specified and backfill to grade with compacted fill:
 - (1) Under surfaced areas, to six inches (6") below top of respective subgrades for such areas.
 - (2) Under lawn and planted areas, to twenty-four inches (24") below finished grade, except that boulder or protruding rock outcrop, if so indicated, shall be left undisturbed.
 - 2. Grading:
 - a. Grade and compact all areas within Project Site, including excavated and filled sections and adjacent transition areas, reasonably smooth, and free from irregular surface changes.
 - b. Degree of finish for rough grading shall be that ordinarily obtained from blade grader or scraper operations except as otherwise specified with due allowance for topsoil.
 - c. Finished grades shall generally be not more than 0.1 feet (0.1') above or below those indicated.
 - d. Finish all ditches, swales, and gutters to drain readily.
 - e. Unless otherwise indicated, slope the subgrade evenly to provide drainage away from all structures in all directions at a grade not less

than one-quarter inch per foot (1/4 in/ft) for a minimum distance of ten feet (10').

- f. Provide roundings at top and bottom of banks and at other breaks in grade.

3.05 TOPSOILING:

- A. Material: Use the most suitable material obtained from stripping operations and borrow when required.
 - 1. Placement:
 - a. Clear areas free of vegetation, rock, and other materials which would interfere with grading and tillage operations.
 - b. Bond topsoil to subgrade by scarifying subgrade to a depth of twelve inches (12").
 - c. Spread topsoil to a minimum depth of eight inches (8") where grading operations have left less than four inches (4") of topsoil in place.
 - d. Grade topsoil to bring areas to grades as indicated, to ensure that all surfaces are left in an even and properly compacted condition, and to prevent ponding of water in depressions.
 - 2. Cleanup:
 - a. Clean surface free of all stones or other objects larger than two inches (2") in least dimension, all roots, brush, wire, grading stakes, and other objectionable materials.
 - b. Keep paved areas clean and promptly remove rock and dirt dropped upon surfacing.

3.06 MAINTENANCE:

- A. Protect newly graded and topsoiled areas from actions of the elements.
- B. Fill and repair settling, or erosion occurring prior to acceptance of the Work and reestablish grades to required elevations and slopes.
- C. Under provisions of the guarantee, correct any settlement of embankment, fill, or backfill and damages created thereby within one (1) year after Initial Acceptance of the Work. Make repairs within ten (10) days after notification by Owner of settlement.

3.07 FIELD QUALITY CONTROL (QC):

- A. Compaction:
 - 1. Contractor will, through services of an independent laboratory, test all embankments, fills, and subgrades under this Contract to determine conformance with specified density relationships.
 - 2. Method of test may be either of the following at Engineer's option:
 - a. ASTM D1556.
 - b. ASTM D2167.
 - c. ASTM D6938.
 - 3. The frequency of in-place compaction testing including density and moisture content will be as follows:
 - a. At least one (1) test for every one thousand cubic yards (1,000 yd³) of material placed in a mass fill.
 - b. At least one (1) test for every two hundred cubic yards (200 yd³) of fill placed in trenches or surrounding structures.

- c. At least one (1) test per 2,500 square feet (2,500 ft²) per lift of compacted soil liner or fill in roadbed.
 - d. At least one (1) test for every 2,500 square feet (2,500 ft²) of subgrade for fill or soil liner.
 - e. At least one (1) test for every one hundred linear feet (100 LF) of roadway for road subgrades and crushed rock base course.
 - f. At least one (1) test for every five hundred square feet (500 ft²) per lift in structural fill or on subgrades for foundations.
 - g. At least one (1) test for every shift of compaction operation on a mass fill.
- 4. At least one (1) test when Engineer suspects quality of moisture control or effectiveness of compaction. Remove or scarify fill failing to meet required densities and recompact as necessary to achieve specified results.
 - 5. Removal of in-place material and replacement with approved new material will be required if scarifying and recompaction do not produce the required densities.
 - 6. Perform at least one (1) classification test ASTM D2487 and one (1) moisture-density test ASTM D698 on soil used in fill or backfill operations during construction.
 - a. Each sample shall be taken from trenches or other excavations as directed by Engineer and should be generally representative of distinguishably differing materials encountered and used for backfill or fill.
 - b. Perform one (1) set of tests at the beginning of excavation and one (1) additional set of tests when material properties vary (more or less plastic, different color, more or less granular, etc.) from the material initially tested.
 - c. Additional tests shall be performed when directed by Engineer.
- B. Controlled Low-Strength Material (CLSM):
- 1. Determine unconfined compressive strength using cylinders of CLSM sampled, handled, cured, and tested in accordance with ASTM D4832. Perform a minimum of one (1) set of four (4) cylinders for every one hundred fifty cubic yards (150 yd³) of CLSM placed but not less than one (1) set for each day's placement, unless otherwise directed by Engineer.
 - 2. Determine bearing strength, if required by Engineer, using penetration testing in accordance with ASTM C403.
 - 3. Test flow of CLSM, if required by Engineer, in accordance with ASTM C939.
- C. Subgrades:
- 1. Engineer will inspect all subgrades to determine conformance with indicated lines and grades.
 - 2. Subgrades for roadways, drives, parking areas, and railroads shall have a maximum deviation of not more than one-half inch (1/2") in any ten feet (10') when tested with a 10-foot straightedge applied parallel with and at right angles to centerlines of subgrade areas. Actual grade shall not be more than 0.1 feet (0.1') from indicated grade.

END OF SECTION 31 20 50

SECTION 31 20 55 - SEDIMENTATION AND EROSION CONTROL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.02 SUMMARY:

- A. This Section includes:
 - 1. All related items necessary to complete the Work indicated or specified.
 - 2. Erosion protection and sediment control measures shall comply with all requirements for other local, state, and federal permits associated with erosion protection and sediment control. This shall include, but may not be limited to, the permits described in the Project's Contract, and the City of Thornton's General and Special Conditions.

1.03 REFERENCE STANDARDS:

- A. Applicable Standards:
 - 1. City of Thornton's General and Special Conditions
 - 2. Mile High Flood District's Urban Storm Drainage Criteria Manual, latest edition.
 - 3. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR Part 1926 - Safety and Health Regulations for Construction.
 - 4. Standard Specifications for Road and Bridge Construction, Colorado Department of Transportation (CDOT), 2021.
 - 5. City of Thornton's Standards and Specifications for the Design and Construction of Public and Private Improvements, October 2012.

1.04 SUBMITTALS:

- A. Erosion Protection and Sediment Control Plan (EPSCP): Approval is required prior to starting work. The EPSCP shall meet the requirements of Mile High Flood District's Urban Storm Drainage Criteria Manual.
 - 1. Coordinate with suggested Grading, Erosion and Sediment Control (GESC) Drawings developed by the Engineer. The EPSCP shall include, at a minimum, the following information:
 - a. Facilities, products, and procedures to meet the requirements of erosion protection and sediment control requirements of all required Project permits and requirement of these Specifications.
 - b. Procedure, installation details, and constructing all required erosion protection and sediment control facilities.
 - c. Procedures and schedule to inspect, maintain, monitor, and repair erosion protection and sediment control facilities.
 - d. Product data of proposed material to be used to protect from erosion and control sediment.
 - e. Contract Drawings that clearly show erosion protection and sediment control measures to be used for each stage of construction.
 - f. Schedule of removal of sediment control and erosion protection devices.
 - g. Stormwater Management Plan (SWMP) in accordance with the City of Thornton's Special Conditions.

PART 2 - PRODUCTS

2.01 SILT FENCE:

- A. Polyester, polypropylene, or nylon filaments, woven into a uniform pattern, distinct and measurable openings.
- B. Materials to be accordance to Table 1:

TABLE 1		
Physical Property	Required Value	Test Method
Weight, ounces/yd ² , minimum	4	ASTM D3776
Equivalent opening Size, maximum	50-70	U.S. Standard Sieve
Grab Tensile Strength, lb, minimum	120	ASTM D4632
Elongation, %, maximum	15	ASTM D4633
Mullen Burst Strength, psi, minimum	300	ASTM D3786
UV Radiation Resistance, % Strength Retention	70	ASTM D4355
Flow Rate, gal/min/ft ² , minimum	10	ASTM D4491
UV Radiation Stability, %, minimum	90	ASTM G 26

- C. Support Fence:
 - 1. Wire Mesh Material: As recommended by manufacturer of geotextile; strong enough to support allied loads.
 - 2. Support posts: As recommended by manufacturer of geotextile.
 - 3. Fasteners: Heavy-duty wire staples at least one inch (1") long, tie wires or hog rings, as recommended by manufacturer of geotextile.

2.02 SEDIMENT CONTROL LOGS (SCL):

- A. Straw-filled tube of flexible netting material. Machine-produced tube of compacted rice straw that is Certified Weed Free Forage. Netting shall consist of seamless, high-density polyethylene and ethyl vinyl acetate and contain UV-inhibitors.
- B. Meet the minimum performance requirements in Table 2:

TABLE 2		
Physical Property	Required Value	Test Method
Mass per unit weight, lb/ft	1.6	Field Measured
Dimension, inch diameter	8.0-9.0	Field Measured
Net Strand thickness, inch	0.03	Field Measured
Netting unit Weight, ounces/ft	0.35	Certified
Sediment Retention capacity, lb/ft	30	Rainfall Sim. ⁽¹⁾
Installed Free-Board Ht., inches	6.0-7.0	Field Measured
Soil Loss ⁽¹⁾ , % effectiveness	58 ⁽²⁾	Rainfall Sim. ⁽¹⁾
De-stabilizing Moisture, % Retained (max.)	11	Rainfall Sim. ⁽¹⁾

Notes:

- (1) Minimum of three (3) 10-year predicted storm events on three horizontal to one vertical (3H:1V) slope with clayey sand type soil.
- (2) Minimum sediment yield reduction value.

PART 3 - EXECUTION

3.01 SEDIMENT CONTROL AND EROSION PROTECTION INSTALL:

- A. Install erosion protection facilities to the required lines, levels, contours, and datums shown on the approved sediment and erosion control plan to prevent sediment from entering in neighboring rivers, streams, ponds, and areas.
- B. Install sediment control and erosion protection facilities prior to work involving site clearing, stripping and stockpiling topsoil, excavation, and earthwork.
- C. Maintain and repair sediment controls and erosion protection during course of construction.

3.02 SITE PREPARATION:

A. Silt Fence:

- 1. Install silt fence as indicated and as follows:
 - a. On the downslope side(s) of all disturbed and stockpile areas.
 - b. Install in one-piece or continuously sewn to make one-piece geotextile for full height of the fence, including portion buried in the toe trench.
 - c. When joints are necessary, splice geotextile together only at a support post, with a minimum 9-inch overlap, and securely fasten both ends to support post.
 - d. Geotextile shall not extend more than twenty-four inches (24") above the ground surface. Securely fasten to upslope side of each support post using ties or staples. Bottom portion of geotextile shall be securely backfilled in toe trench such that it is not easily pulled out by hand. Geotextile shall not be stapled to existing trees.
 - e. Fasten wire mesh material support fence securely to up slope side of post fasteners. Extend wire into the trench a minimum of four inches (4"), and not more than thirty-six inches (36") above the ground surface.
 - f. Take precaution not to puncture geotextile during installation. Repair or replace damaged area.
- 2. Inspection:
 - a. Daily in areas of active construction or equipment operation.
 - b. Weekly in areas with no construction or equipment operation.
 - c. Within twenty-four (24) hours of each one-half inch (1/2") or greater rainfall event.
 - d. Complete inspection reports after each inspection and submit to Engineer within two (2) working days.
- 3. Maintenance:
 - a. Remove sediment from behind silt fence when it reaches one-third (1/3) the height of fence. Place removed sediment in topsoil stockpile areas.
 - b. Any silt fence damaged so it cannot perform its intended function shall be replaced as indicated or as directed by Engineer.
 - c. Remove silt fence after area has been surfaced or seeded and has been accepted by Engineer.
 - d. Payment for silt fence replacement shall conform to the Unit Price for Silt Fence stated in Agreement.

B. Sediment Control Logs (SCL):

1. Excavate a small trench, two to three inches (2-3") in depth on the slope contour and perpendicular to the water flow. Soil from the excavation should be placed downslope next to the trench.
 2. Install the SCL in the trench, ensuring that no gaps exist between the soil and the bottom of the SCL. The ends of the adjacent SCLs should be tightly abutted so that no opening exists for water or sediment to pass through.
 3. Wooden stakes should be used to fasten the SCL to the soil. Place Stakes at four feet (4') on center.
 4. Terminal ends of SCL should be doglegged upslope to ensure containment and prevent channeling of sedimentation.
- C. Removal of Temporary Facilities:
1. Do not remove erosion protection facilities without written approval from Engineer.
 2. All erosion protection facilities will be the property of the Contractor and shall be removed and disposed of off-site after all Work is complete.
 3. Remove and dispose of sediment collected in the sediment control systems in accordance to permits.
- D. Inspection and Quality Control (QC):
1. Perform weekly inspections of all erosion protection and sediment control facilities.
 2. Repair and correct all identified deficiencies.
- E. Construction Access:
1. Immediately remove by shoveling and/or sweeping all sediment tracked from the construction area onto Site access roads. Place sediment in stockpile areas.

END OF SECTION 31 20 55

SECTION 31 23 33.13 - TRENCHING AND BACKFILLING FOR UTILITIES

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes:
 - 1. Excavation, sheeting, bracing, and all operations necessary for the preparation of trenches for bedding of pipes and pipe appurtenances, conduit, and buried cable.
 - 2. Pipe embedment's and encasements.
 - 3. Backfilling of trenches.
- B. Related Work Specified Elsewhere:
 - 1. Section 31 20 50 - "Site Preparation and Earthwork."

1.02 REFERENCES:

- A. Applicable Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M147 - Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
 - b. T99 - The Moisture-Density Relations of Soils Using a 5.5-Pound Rammer and a 12-Inch Drop.
 - c. T104 - Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
 - 2. ASTM International (ASTM):
 - a. D4253 - Test Method for Maximum Index Density of Soils Using a Vibratory Table.
 - b. D4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - 3. Occupational Safety and Health Administration (OSHA):
 - a. Part 1926 - Safety and Health Regulations for Construction.
 - 4. Standard Specifications for Road and Bridge Construction, Colorado Department of Transportation (CDOT), 2021.
 - 5. City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012.

1.03 SUBMITTALS:

- A. Submit as directed by Owner.
- B. Where selecting an option for excavation, trenching, and shoring in compliance with local, state, or federal safety regulations such as "OSHA Part 1926" or successor regulations, which require design by a registered professional engineer (P.E.), submit (for information only and not for Engineer approval) the following:
 - 1. Copies of design calculations and notes for sloping, benching, support systems, shield systems, and other protective systems prepared by or under the supervision of a professional engineer legally authorized to practice in the jurisdiction where the Project is located.

2. Documents provided with evidence of registered professional engineer's seal, signature, and date in accordance with appropriate state licensing requirements.

PART 2 - PRODUCTS

2.01 GRANULAR PIPE EMBEDMENT:

- A. Material:
 1. Gravel or crushed stone which shall not have a loss of more than fifteen percent (15%) after five (5) cycles when tested for soundness with sodium sulfate as described in AASHTO T104.
- B. Gradation:

Sieve Size (Square Openings)	Percent (%) Passing by Weight
3/8-inch	100
No. 200	0-5

2.02 TRENCH STABILIZATION MATERIAL:

- A. Contractor to use material per City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012, Standard Drawing 200-5.
- B. Imported, well graded crushed rock with cobble-sized pieces the meet the following:
 1. Gradation, as determined in accordance with ASTM C136:

Sieve Size	Percent (%) Passing by Weight
6-inch	100
3-inch	90-100
1-1/2-inch	60-95
3/4-inch	20-70
3/8-inch	10-40
No. 4	0-20
No. 16	0-50
No. 200	0-3

2. Abrasion Resistance: Maximum thirty-five percent (35%) wear when tested in accordance with ASTM C 535.
3. Minimum Specific gravity of 2.65 when tested in accordance with ASTM C 127.
- C. Free from deleterious matter.

2.03 CONTROLLED LOW-STRENGTH MATERIAL (CLSM) OR FLOWABLE FILL:

- A. Low strength flowable fill with a 7-day compressive strength not less than 100 psi or more than 200 psi as determined in accordance with ASTM D4832.
- B. All CLSM (flow-fill and flashfill) shall meet the following requirements for mix design:

1. Flow-fill (low strength concrete):
 - a. Flow-fill is a self-leveling concrete material composed of cement, fly ash, aggregates, water, chemical admixtures, and/or cellular foam for air-entrainment.
 - b. Flow-fill shall have a slump of seven to ten inches (7-10"), when tested in accordance with ASTM C143 or a minimum flow consistency of six inches (6") when tested in accordance with ASTM D6103.
 - c. Flow-fill shall have a minimum compressive strength of 50 psi at twenty-eight (28) days, when tested in accordance with ASTM D4832.
 - d. Flowable low strength concrete fill shall be a thoroughly mixed combination of the following ingredients:

CLSM - Flowfill	
Ingredients	lb/yd³
Cement	50
Coarse Aggregate	1,700 (AASHTO No. 57 or 67)
Fine Aggregate	1,845 (AASHTO M6)
Water	325 (or as needed)
RE	Less than 1.0

- e. The amount of water shall be such that the flow-fill material flows into place properly without excessive segregation.
- f. Approximately thirty-nine (39) gallons of water per cubic yard of flow-fill is normally needed
- g. The Contractor may use aggregate which does not meet the above specifications if the cement is increased to one hundred pounds per cubic yard (100 lb/yd³) and the aggregate conforms to the following gradation:

Sieve Size	Percent (%) Passing by Weight
1-inch	100
No. 200	0-10

- h. The Contractor may substitute 30 pounds per cubic yard of cement and 30 pounds per cubic yard of fly ash for 50 pounds per cubic yard of cement
- i. The Contractor may substitute 60 pounds per cubic yard of cement and 60 pounds per cubic yard of fly ash for 100 pounds per cubic yard of cement.
- j. Cement shall conform to applicable requirements of City of Thornton Standards and Specifications (Rev Oct 2012) Section 600
 - (1) Sulfate resistant cement shall be used in areas prone to sulfate attack

2. Flashfill (cementitious fly ash):
 - a. Shall consist of a controlled low-strength, self-leveling cementitious material composed of various combinations of cement, fly ash, water, chemical admixtures, and/or cellular foam for air-entrainment.
 - b. Low strength flowable fill with a 28-day compressive strength not less than 100 psi or more than 300 psi as determined in accordance with ASTM D4832.
 - c. Fly ash shall meet the requirements of ASTM C618 Type C or Type F.
 - d. Use only potable water or water clean and free of chemicals
 - e. Entrainments and Admixtures:
 - (1) Air-entraining admixtures shall conform to the requirements of ASTM C260.
 - (2) Foaming agents shall conform to the requirements of ASTM C869 and C796, or as otherwise approved by the engineer
 - f. Flowable fly ash fill shall be a thoroughly mixed combination of the following ingredients:

CLSM - Flashfill	
Ingredients	lb/yd³
Class C Fly Ash	200 - 400
Class F Fly Ash	1,600 - 1,800
Water	800 (or as needed for consistency)
Cellular air entrainment admixture (Foam)	As required to produce 15% air content or greater
RE	Less than 1.0

- g. Flashfill backfill shall be of the removable type
- h. Flashfill shall be air entrained with a “foaming” cellular admixture which provides frost heave resistance and to improve removability.
 - (1) Flashfill shall have a air content of fifteen to twenty-five percent (15-25%), when tested in accordance with ASTM C231
- i. Slump:
 - (1) The mix shall result in a product having a slump in the range of eight to eleven inches (8-11”), when tested in accordance with ASTM C142.
 - (2) Slumps of less than seven inches (7”) will not be permitted for placement, since the flowability to avoid settlement is impaired, and strengths may increase.

2.04 **CONCRETE:**

- A. See City of Thornton Standards and Specifications (Rev Oct 2012) Section 600.

2.05 **TRENCH BACKFILL MATERIALS:**

- A. Obtain from the following:
 1. Trenches and other excavations included in Project.
 2. Borrow from location off Site.
 3. As specified for pipe embedment.
 4. Combination of above.

- B. Free from organic matter, refuse, ashes, cinders, frozen, or other unsuitable material.
- C. Gravel, rock, or shale particle size limited as follows:
 - 1. Not to exceed 2 inches in greatest dimension within 12 inches of pipe or conduit and upper 18 inches of trench.
 - 2. Gravel, rock, or shale not allowed within 12 inches of buried cable.
 - 3. Maximum dimension one-half the depth of layer to be compacted in other areas.
- D. Contain sufficient fine materials to provide a dense mass free of voids and capable of satisfactory compaction.
- E. Have moisture content enabling satisfactory placement and compaction.
- F. Blended or otherwise processed to provide required gradation and obtain moisture content at time of placement of not less than two percent (2%) below or more than two percent (2%) above optimum as determined by AASHTO T99.
- G. Use granular material as specified for pipe embedment and trench stabilization under shoulders and driveways.

PART 3 - EXECUTION

3.01 TRENCHING:

- A. Equipment and Methods:
 - 1. Types of Equipment and methods may be at Contractor's option, where structures or other facilities are not endangered.
 - 2. Equipment and methods shall be subject to approval of jurisdictional agency where stability or usefulness of other facilities may be impaired.
 - 3. Perform by hand methods when required to save or protect trees, culverts, utilities, or other structures above or below ground.
- B. Side Walls:
 - 1. Make vertical or slope within specified trench-width limitations below a horizontal plane twelve inches (12") above top of pipe.
 - 2. Vertical or sloped (stepped) as required for stability, above a horizontal plane twelve inches (12") above top of pipe.
 - 3. Sheet and brace where necessary.
 - 4. Excavate without undercutting.
- C. Trench Depth:
 - 1. Depth shall be sufficient to provide the minimum bedding requirements for the pipe being placed.
 - 2. Do not exceed the indicated depth where conditions of bottom are satisfactory.
 - 3. Increase depth as necessary to remove unsuitable supporting materials.
- D. Trench Bottom:
 - 1. Protect and maintain when suitable natural materials are encountered.
 - 2. Remove rock fragments and materials disturbed during excavation or raveled from trench walls.
 - 3. Restore to proper subgrade with trench stabilization material when overexcavated:
 - a. Correct, at no additional cost to Owner, when trench is overexcavated without authority or to stabilize bottom rendered unsuitable through negligence or improper operations.

- b. Placement of Trench Stabilization Material:
 - (1) Compact in lifts not exceeding 6-inch loose thickness:
 - (a) With pneumatic or vibratory equipment.
 - (b) To density specified for granular pipe embedment.

E. Trench Width:

- 1. Excavate trench to a width which will permit satisfactory jointing of the pipe and thorough tamping of the bedding.
- 2. Minimum Trench Width:

Line Type	Pipe Material	Nominal Pipe Size (in)	Pipe Outside Diameter (O.D.) (in)	Min. Trench Width (in)
Potable Water Distribution	DR-18 PVC	6	6.90	See Special Bedding Detail
		8	9.05	See Special Bedding Detail
		12	13.20	See Special Bedding Detail

3. Maximum Trench Width:

- a. Below a plane twelve inches (12") above top of pipe or as defined by top of pipe embedment.

Line Type	Pipe Material	Nominal Pipe Size (in)	Pipe Outside Diameter (O.D.) (in)	Max. Trench Width (in)
Potable Water Distribution	DR-18 PVC	6	6.90	See Special Bedding Detail
		8	9.05	See Special Bedding Detail
		12	13.20	See Special Bedding Detail

- b. Above plane defined in "a", no maximum limit.
- c. Maximum trench-width limitations shall apply beginning three feet (3') from manhole or structure walls.
- d. Maximum width shall be as near the minimum specified as can be controlled by construction equipment and methods used.
- e. Correct when overexcavated at no additional cost to Owner:
 - (1) Use stronger pipe or higher class embedment.
 - (2) Obtain approval of Engineer before proceeding.

F. Trenching in Fill Areas: Perform trenching in fill areas only after compacted fill has reached an elevation of not less than one foot (1') above the top of the pipe.

G. Test Pits:

1. Excavate test pits sufficiently in advance of trenching to enable adequate planning of construction procedure.
2. Locate as follows:
 - a. Where unstable material is suspected that may require special protective measures.
 - b. Where groundwater may require special handling methods.
 - c. Where advisable to assess adequacy of blasting pattern.
 - d. Where indicated or otherwise approved.
 - e. Where interference or conflict with other utilities or structures could affect alignment of pipe.
3. With lateral dimension not less than minimum trench width specified for location excavated.
4. To depth required to obtain information desired.

3.02 PIPE EMBEDMENTS AND ENCASEMENTS:

A. Granular Pipe Embedment:

1. Place granular embedment as follows:
 - a. Level bottom layer at proper grade to receive and uniformly support pipe barrel throughout its length.
 - b. Form depression under each joint so that no part of bell or coupling is in contact with trench when pipe is placed in position.
 - c. Add second layer simultaneously to both sides of the pipe with care to avoid displacement.
 - d. Complete promptly after completion of jointing operations and approval to proceed.
2. Compact granular bedding as follows:
 - a. In lifts not exceeding twelve inches (12") in compacted depth.
 - b. Rod, spade, or use pneumatic or vibratory equipment:
 - (1) As required to obtain not less than eighty percent (80%) relative density as determined by ASTM D4253 and D4254.
 - (2) Throughout depth of embedment.

3.03 BACKFILLING:

A. Placement:

1. Complete promptly after approval to proceed:
 - a. Upon completion of pipe embedment.
 - b. Only after concrete encasement has obtained seventy percent (70%) of design strength. Determination of design-strength percentage obtained shall be as specified City of Thornton Standards and Specifications (Rev Oct 2012) Section 600.
2. Use hand methods to a horizontal plane twelve inches (12") above top of pipe, conduit, or duct banks.
3. Use approved mechanical methods where hand backfill is not required.
4. Place in layers of thickness within compacting ability of equipment used.
5. Until compacted depth over conduit exceeds three feet (3'), do not drop fill material over five feet (5'). Then distance may be increased two feet (2') for each additional one foot (1') of cover. Backfill conduit trenches in layers of four to eight inches (4-8").

B. Compaction:

1. Sites 1-5 and sites 7-8 should use the AASHTO T-99 proctor. Site 6 will require a modified proctor (AASHTO T-180) to be utilized.
2. Perform at moisture content necessary to achieve required results with equipment used.
3. Perform with spreading equipment supplemented by hand-operated equipment and rollers as required to obtain density specified.
4. Accomplish without inundation or flooding.
5. Achieve following densities:
 - a. Unless otherwise specified, adequate to prevent significant future settlement.
 - b. Under pavements and shoulders:
 - (1) Cohesive Soils:
 - (a) Entire depth - 95%.
 - (2) Cohesionless Soils:
 - (a) Entire depth - 95%.
 - c. Boulevards, berms, median strips, etc.:
 - (1) Entire depth - 90%.
6. Backfill failing to meet required densities shall be removed or scarified and recompacted as necessary to achieve specified results.

3.04 FIELD QUALITY CONTROL (QC):

- A. Compaction: Contractor will, through services of an independent laboratory, test all trench-stabilization material, granular pipe embedment, earth-pipe embedment, clay cut-off walls, and trench backfill to determine conformance with specified moisture-density relationships:
 1. Method of test will be as specified in Section 31 20 50 - "Site Preparation and Earthwork," PART 3.
- B. Concrete: Contractor shall test all concrete for use in encasements, cradles, and concrete cut-off walls to determine conformance with Specifications. Method of test shall be as specified in City of Thornton Standards and Specifications (Rev Oct 2012) Section 600 .

END OF SECTION 31 23 33

SECTION 31 23 33.16 – TRENCHING AND BACKFILLING FOR UTILITY STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes all necessary excavation, filling, and backfilling for structures and all related Work, including duct banks and manholes.
- B. Related Work Specified Elsewhere:
 - 1. Section 31 20 50 – “Site Preparation & Earthwork.”
 - 2. Section 31 23 33.13 – “Trenching and Backfilling For Utilities.”

1.02 REFERENCES:

- A. Applicable Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T99 - The Moisture-Density Relations of Soils Using a 5.5-lb Rammer and a 12-Inch Drop.
 - 2. ASTM International (ASTM):
 - a. D4253 – Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - b. D4254 – Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - 3. Occupational Safety and Health Administration (OSHA):
 - a. Part 1926 – Safety and Health Regulations for Construction.

1.03 SUBMITTALS:

- A. Submit as specified in Thornton’s General and Special Conditions
- B. Where selecting an option for excavation, trenching, and shoring in compliance with local, state, or federal safety regulations such as “OSHA Part 1926” or successor regulations, which require design by a registered professional engineer, submit (for information only and not for Engineer approval) the following:
 - 1. Copies of design calculations and notes for sloping, benching, support systems, shield systems, and other protective systems prepared by or under the supervision of a professional engineer legally authorized to practice in the jurisdiction where the Project is located.
 - 2. Documents provided with evidence of registered professional engineer’s seal, signature, and date in accordance with appropriate state licensing requirements.

PART 2 - PRODUCTS

2.01 FILL AND BACKFILL MATERIAL:

- A. Earth Backfill: Use suitable material as specified in Section 31 20 50 – “Site Preparation and Earthwork”, PART 2.
- B. Granular Fill: Use material as specified in Section 31 23 33.13 – “Trenching and Backfilling For Utilities,” PART 2 for granular pipe embedment.

- C. CLSM Fill: Use material as specified in Section 31 23 33.13 – “Trenching and Backfilling For Utilities,” PART 2 for Controlled Low Strength Material (CLSM).

2.02 CONCRETE:

- A. Includes all concrete used to restore bottom of excavation to proper elevation, and in concrete seal coats.
- B. See City of Thornton Standards and Specifications (Rev Oct 2012) Section 600

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Perform as specified in Section 31 20 50 – “Site Preparation and Earthwork” and as follows:
 - 1. Excavate area adequate to permit efficient erection and removal of forms.
 - 2. Trim to neat lines where details call for concrete to be deposited against earth.
 - 3. Excavate by hand in areas where space and access will not permit use of machines.
 - 4. Notify Engineer immediately when excavation has reached the depth indicated. Do not proceed further until approved.
 - 5. Restore bottom of excavation to proper elevation with compacted granular fill in areas over excavated, as approved.
 - 6. Use sides of trenches to form sides of duct banks where possible and where sides of trench are vertical, stable, and excavated to the proper line.
- B. Sheeting and Bracing:
 - 1. Design, furnish, place, maintain, and subsequently remove, to extent required, a system of temporary supports for cut and cover, open cut, or trench excavations, including bracing, dewatering, and associated items to support sides and ends of excavations where excavation slopes might endanger in-place or proposed improvements, extend beyond construction rights-of-way, or as otherwise specified or indicated.
 - 2. Provide all materials on Site prior to start of excavation in each section, and make such adjustments as are required to meet unexpected conditions.
 - 3. Space and arrange sheeting and bracing as required to exclude adjacent material and according to stability of excavation slopes.
 - 4. Assess existing conditions including adjacent property and possible effects of proposed temporary works and construction methods; and select and design such support systems, methods, and details as will assure safety to the public, adjacent property, and the completed Work.
 - 5. Modify or relocate underground facilities, at no additional cost to Owner, if existing underground facilities interfere with Contractor's proposed method of support.
 - 6. Use caution in areas of underground facilities, which shall be exposed by hand or other excavation methods acceptable to Owner.
 - 7. Perform sheeting, shoring, and bracing in accordance with safety and protection requirements of the Contract Documents.
 - 8. Provide sheeting, shoring, and bracing for trench excavation in subgrade of excavation when required to prevent movement of the main excavation support system.

9. Provide shoring, sheeting, and bracing as indicated or as needed to meet the following requirements:
 - a. Prevent undermining and damage to all structures, buildings, underground facilities, pavements, and slabs.
 - b. Perform excavations with vertical banks where necessary for construction activities or as indicated, and also within all limits of excavation noted on Contract Drawings.
 - c. Design excavation support system and components to support lateral earth pressures, unrelieved hydrostatic pressures, utility loads, traffic and construction loads, and building and other surcharge loads to allow safe and expeditious construction of permanent structures without movement or settlement of the ground, and to prevent damage to or movement of adjacent buildings, structures, underground facilities, and other improvements. Design shall account for staged removal of bracing to suit the sequence of concrete placement for permanent structures and backfill.
 - d. Except as otherwise specified herein, shoring and sheeting materials may be extracted and reused at Contractor's option; however, Contractor shall remove and replace any existing structure or underground facility damaged during shoring and sheeting. Remove sheeting and bracing as backfill progresses. Fill voids left after withdrawal with sand or other material approved by Engineer.
 - e. Where shoring and sheeting materials must be left in-place in the completed Work to prevent settlements to or damage within adjacent structures or as directed by Engineer, backfill the excavation to 3 feet below finished grade and remove the remaining exposed portion of shoring before completing backfill. If soldier piles and wood lagging are used for shoring, remove wood lagging to within 3 feet of finished grade in incremental steps of approximately 6 inches as backfill is placed, or to Contractor's design if more stringent. Location of all shoring and sheeting left in-place shall be documented on Contractor-furnished construction record drawings and provided to Engineer and Owner.
10. Contractor shall be solely responsible for proper design, installation, operation, maintenance, and any failure of any component of the system. Review by Engineer of drawings and data submitted by Contractor shall not in any way be considered to relieve Contractor from full responsibility for errors therein or from the entire responsibility for complete and adequate design and performance of the sheeting and shoring system.
11. Provision for Contingencies:
 - a. Performance of components of the support system shall be monitored for both vertical and horizontal movement daily.
 - b. Provide a contingency plan or alternative procedure for implementation, if system does not adequately perform.
 - c. Keep materials and equipment necessary to implement the contingency plan readily available.
12. Damages:
 - a. Document all existing damage to adjacent facilities and submit information to Owner prior to performing any excavation. Documentation

shall include a written description, diagrams, measurements, and appropriate photographs.

- b. Repair all damage resulting from Contractor's excavation and remove and replace all undermined pavements with Owner approved equal, either concrete or asphalt, at no expense to Owner.

3.02 FILLING AND BACKFILLING:

A. Granular Fill:

1. Place on prepared subgrade where indicated, prior to placing concrete on grade.
2. Lifts shall not exceed 6 inches in loose-layer thickness.
3. Compact to 95% relative density as referenced to ASTM D4253 and D4254.

B. Earth Backfill:

1. Backfill only after concrete has attained 70% design strength.
2. Backfill adjacent to structures only after, in the opinion of Engineer, a sufficient portion of the structure has been built to resist the imposed load.
3. Remove all debris from excavation prior to placement of material.
4. The slope bounding the excavation, if steeper than 6 horizontal: 1 vertical, shall be stepped or serrated prior to placing the backfill material.
5. Perform backfilling simultaneously on all sides of structures.
6. Place backfill in level loose lifts of thickness within compacting ability of equipment used but not to exceed 8 inches in thickness.
7. Exercise extreme care in the use of heavy equipment in areas adjacent to structures. Equipment operated within 10 feet of any wall shall not exceed 20,000 pounds gross weight.
8. Compact to 95% of maximum dry density within the moisture content range from 3% below optimum to 3% above optimum. Optimum moisture and maximum dry density shall be determined by AASHTO T99. Accomplish without inundation or flooding.
9. Material above a 45° plane intersecting the footing shall not include rock fragments incapable of passing a 6-inch screen, and no shale whether disintegrated or not.

3.03 FIELD QUALITY ASSURANCE:

A. Compaction:

1. Contractor will, through services of an independent laboratory, test all filling and backfilling for structures to determine conformance with density relationships specified.
2. Method of test shall be as specified in Section 31 20 50 – “Site Preparation and Earthwork,” Part 3.
3. The frequency of tests shall be in compliance with jurisdictional requirements or as otherwise required by Owner.

END OF SECTION 31 23 33.16

DIVISION 32 EXTERIOR IMPROVEMENTS

SECTION 32 11 23 - AGGREGATE BASE COURSE

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes crushed rock base and surface course and method of placement for roadways on the Project.
- B. Related Work Specified Elsewhere:
 - 1. Section 31 20 50 - "Site Preparation and Earthwork."

1.02 REFERENCES:

- A. Applicable Standards:
 - 1. ASTM International (ASTM): Equivalent AASHTO standards may be substituted as approved.
 - a. C29 - Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.
 - b. C88 - Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate.
 - c. C117 - Test Method for Materials Finer than No. 200 Sieve in Mineral Aggregates by Washing.
 - d. C131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - e. C136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - f. D75 - Practice for Sampling Aggregates.
 - g. D698 - Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
 - h. D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³).
 - i. D2419 - Test Methods for Sand Equivalent Value of Soils and Fine Aggregate.
 - j. D3665 - Practice for Random Sampling of Construction Materials.
 - k. D4318 - Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - l. D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 - 2. State of Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction.
 - 3. City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012.

1.03 QUALITY ASSURANCE (QA):

- A. Sampling and Testing:
 - 1. Tests to determine conformance with all requirements of this Specification for quality and properties of all Contractor-secured sources of materials shall be performed by an independent commercial laboratory retained and

- compensated by Contractor and approved by Engineer. In lieu of testing, Contractor may submit certified state test results indicating the aggregate meets Specification requirements to Engineer for approval.
2. Obtain representative samples of material in accordance with ASTM D75 for testing. Furnish laboratory sufficient material for testing from each sample at the time obtained. Copies of reports and certificates regarding tests and inspection of materials shall be distributed as specified in Thornton's General and Special Conditions. Furnish specific schedule for sampling to provide Engineer the opportunity to observe sampling.
 3. When incorporating materials into the Work, quality control (QC) testing will be performed during construction by a testing laboratory retained and compensated by Owner.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. Crushed rock base and surface course shall consist of aggregate specified.

2.02 AGGREGATE:

- A. Aggregate shall be crushed stone or crushed gravel, free from lumps or balls of clay, dirt, silt, vegetable matter, or other objectionable matter and reasonably free from thin and elongated pieces of aggregate. Aggregates shall consist of angular fragments, durable and sound, and shall be reasonably uniform in density and quality. Fine aggregate passing the No. 4 sieve shall consist of fines from the operation of crushing the coarse aggregate. If necessary, fine aggregate may be added to produce the correct gradation. The fine aggregate shall be produced by crushing stone, gravel, or slag that meet the requirements for wear and soundness specified for coarse aggregate.
- B. Percentage of wear shall not exceed forty-five percent (45%) when tested in accordance with ASTM C131. The sodium sulfate soundness loss shall not exceed twelve percent (12%) after five (5) cycles when tested in accordance with ASTM C88.
- C. Portion of aggregate which is retained on a 3/8-inch sieve shall contain seventy-five percent (75%) by weight of pieces with two (2) or more fractured surfaces if the material is crushed gravel.
- D. Portion of aggregate passing No. 40 sieve shall be as follows:
 1. Liquid Limit: Not more than twenty-five (25) determined by ASTM D4318.
 2. Plastic Index: Not more than four (4) determined by ASTM D4318.
 3. The fine aggregate shall have a minimum sand equivalent value of thirty-five (35) when tested in accordance with ASTM D2419.
- E. Aggregate Base Course:
 1. Gradation shall not vary from low limit on one sieve to high limit on adjacent sieve or vice versa. Aggregate for Base Course shall be Class 6 Aggregate Base Course as specified in CDOT Standard Specifications.

Standard Square-Mesh Sieve U.S. Size or No.	Percent (%) Passing by Weight
3/4-inch	100
No. 4	30-65
No. 8	25-55
No. 200	3-12

2.03 **EQUIPMENT:**

- A. General Requirements:
 - 1. Maintain all equipment, tools, and machines used in the performance of the Work required by this Section in a satisfactory working condition at all times.
 - 2. Equipment shall be subject to the approval of Engineer.
- B. Steel-Wheeled Rollers shall be self-propelled three-wheeled rollers, two-axle tandem rollers, or three-axle tandem rollers.
 - 1. Rollers shall weigh not less than eight (8) tons and develop contact pressures under the compression rolls of not less than two hundred pounds per square inch (200 psi) width.
 - 2. Three-axle tandem rollers shall be so constructed that when locked in position for all treads to be in one plane, the roller wheels are held with such rigidity that if either front or center wheel is unsupported, the other two (2) wheels will not vary from the plane more than one-quarter inch (1/4").
 - 3. Roller wheels shall not have flat areas, openings, or projections.
 - 4. All steel wheels shall be equipped with scrappers, so adjusted to keep the wheels clean at all times.
- C. Rubber-Tired Rollers:
 - 1. Rollers shall consist of two (2) axles on which are mounted not less than nine (9) pneumatic-tired wheels, mounted so the rear group of tires do not follow in the tracks of the forward wheels but will be centered between the forward wheels.
 - 2. The axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading.
 - 3. Inflate tires uniformly.
 - 4. May be self-propelled.
 - 5. Tow with pneumatic-tired tractors or other pneumatic-tired equipment.
- D. Vibratory Rollers:
 - 1. Have either one (1) or two (2) smooth-surfaced steel drum(s) with a minimum diameter of forty-two inches (42").
 - 2. Have a minimum vibrating force of three hundred pounds per cycle per inch (300 lb/cycle/in) of drum width.
 - 3. Have a minimum vibrating frequency of 1,200 cycles per minute and shall be provided with a means of adjusting the resonance of the dynamic force.
 - 4. May be self-propelled or towed.
- E. Blade graders shall be self-propelled with a wheelbase of not less than fifteen feet (15'), and a blade of not less than ten feet (10').
- F. Sprinkling equipment shall consist of tank trucks, pressure distributors, or other similar equipment designed to apply water uniformly and in controlled quantities to variable width of surface.

- G. Hauling equipment shall consist of pneumatic-tired vehicles and dump bodies suitable for dumping materials in windrows or layers on the subgrade.
- H. Tampers shall be mechanical and hand-operated, weigh not less than fifty pounds (50 lb), and have a face area of not more than one hundred square inches (100 in²).
- I. Miscellaneous equipment shall consist of scarifiers, tractors, spring-tooth or spike-tooth harrows, windrow equalizers, spreaders, and other equipment suitable for construction of select material base course.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS:

- A. Stockpiles:
 - 1. Clear and level storage sites prior to stockpiling.
 - 2. Place in the manner and at locations designated by Engineer, providing separate stockpiles for materials from separate sources.
 - 3. Prevent aggregate from segregating during placement, storage, and handling at stockpiles.
- B. Cold-Weather Limitations:
 - 1. Base course construction shall be prohibited when atmospheric temperature is below 35°F, unless approved by writing by Engineer.
 - 2. Do not place base course on frozen subgrade.
 - 3. Protect base course and subgrade in freezing weather and repair areas damaged by freezing by reshaping and recompacting.
- C. Preparation of Subgrade:
 - 1. Clean of all foreign substances.
 - 2. Engineer will inspect for adequate compaction and surface tolerances as specified in Section 31 20 50 - "Site Preparation and Earthwork."
 - 3. Correct any ruts or soft yielding spots or any areas with inadequate compaction, as specified in Section 31 20 50 - "Site Preparation and Earthwork."
- D. Grade Control: Establish and maintain grade by means of grade stakes placed in lanes parallel to the centerline of the area to have crushed rock and spaced so string lines may be stretched between stakes, or by other method as approved by Engineer.

3.02 MIXING AND PLACING OF MATERIALS:

- A. If mixing is required, use stationary plant or road-mix method at Contractor's option.
- B. Stationary-Plant Method:
 - 1. Deposit and spread material in a uniform layer and compact to the thickness indicated and as specified below. Spread material uniformly on the prepared subgrade from moving vehicles or spreader boxes.
 - 2. Level material to the required contour and grades with blade graders.
 - 3. Remove those portions of the layer which become segregated in spreading and replace with satisfactory mixture or remix as requested by Engineer.
- C. Road-Mix Method:

1. Place material without segregation of sizes and spread from spreader boxes or moving vehicles equipped to spread material in layers of uniform thickness.
 2. Mix materials with blade graders, harrows, discs, or other approved equipment. Continue initial mixing until the mixture is uniform throughout.
 3. Add water to the extent necessary to prevent segregation during mixing operations and as needed to meet density requirements.
 4. Add material to the mixture in such amounts and sizes as requested by Engineer.
- D. Shaping and Compacting Mixed Materials:
1. Compact in layers no less than three inches (3") or more than seven inches (7") thick. If the total depth of the compacted material is more than seven inches (7"), it shall be constructed in two (2) or more layers and each layer shall be of approximately equal thickness.
 2. Roll to specified compaction requirements throughout full depth of layer with vibratory rollers, steel-wheeled rollers, rubber-tired rollers, or combination.
 3. Shape and smooth by blading and rolling with power roller or rubber-tired roller or both.
 4. Hand-tamp in places not accessible to rolling equipment.
 5. Aerate by blade graders, harrows, or other approved equipment when mixture is moistened by rain.
- E. Degree of Compaction:
1. Compaction Testing:
 - a. The method of in-place compaction testing shall be as follows:
 - (1) Density - ASTM D6938.
 - (2) Moisture Content - ASTM D6938.
 - b. The minimum frequency of density tests will be as follows:
 - (1) At least one (1) test every fifty linear feet (50 LF) along a roadway or one (1) test every five hundred square yards (500 yd²) of base and surface course placed.
 - (2) At least one (1) test when Engineer suspects the quality of moisture control or effectiveness of compaction.
 2. Aggregate Base Course:
 - a. Base compaction on weight per cubic foot of material passing 3/4-inch sieve and compact each layer to at least one hundred percent (100%) of maximum density at plus or minus 1.5 percent (1.5%) of the optimum moisture as determined by ASTM D698.
 3. Soft Trail Aggregate:
 - a. Compact each layer to at least ninety-five percent (95%) of maximum density at plus or minus 1.5 percent (1.5%) of the optimum moisture as determined by ASTM D698.
 4. Density and moisture content of compacted material shall be measured following the procedures of ASTM D6938. Calibration tests shall be conducted on the first load of material placed that meets density requirements. Calibration checks shall be made at the beginning of the work and at intervals as determined by Engineer.
 5. Remove or scarify and recompact base course failing to meet required densities.

6. Removal of in-place material and replacement with approved new material will be required if scarifying and recompaction do not produce the required densities.
- F. Smoothness Test:
1. Surface shall show no deviation more than one inch (1") in any ten feet (10') when tested with a 10-foot straightedge applied parallel with and at right angles to the centerlines of the paved area.
 2. Correct any deviation more than this amount by loosening, adding or removing material, reshaping, watering, and compacting as requested by Engineer. In no case will the addition of thin layers of material be added to the top layer of base course to meet grade. If the elevation of the top layer is one inch (1") or more below grade, the top layer of base shall be scarified to a depth of at least three inches (3"), new material added, and the layer shall be blended and recompact to bring it to grade. If the finished surface is above plan grade, it shall be cut back to grade and rerolled.

3.03 MAINTENANCE:

- A. Maintain finished base course in a moist condition until the next layer is placed and in a condition satisfactory to Engineer.

END OF SECTION 32 11 23

SECTION 32 12 16 – ASPHALTIC PAVING

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes asphaltic pavement for roads, drives, and parking areas.
- B. Related Work Specified Elsewhere:
 - 1. Section 31 25 50 - "Site Preparation and Earthwork."
 - 2. Section 32 11 23 - "Crushed Aggregate Base Course."

1.02 REFERENCES:

- A. Applicable Standards:
 - 1. Colorado Department of Transportation (CDOT):
 - a. Standard Specifications for Road and Bridge Construction, current edition.
 - (1) Section 301 - Plant Mix Bituminous Base Course.
 - (2) Section 401 - Plant Mix Pavements – General.
 - (3) Section 403 - Hot Bituminous Pavement.
 - (4) Section 407 - Prime Coat, Tack Coat, and Rejuvenating Agent.
 - (5) Section 411 - Bituminous Materials.
 - (6) Section 702 - Bituminous Materials.
 - (7) Section 703 - Aggregates.
 - (8) Section 712 - Miscellaneous.
 - 2. ASTM International (ASTM):
 - a. C29 - Test Method for Unit Weight and Voids in Aggregate.
 - b. C117 - Test Method for Material Finer than No. 200 Sieve in Mineral Aggregates by Washing.
 - c. C127 - Test Method for Specific Gravity and Absorption of Coarse Aggregate.
 - d. C128 - Test Method for Specific Gravity and Absorption of Fine Aggregate.
 - e. C131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - f. C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.
 - g. D75 - Practices for Sampling Aggregates.
 - h. D140 - Practice for Sampling Bituminous Materials.
 - i. D2950 - Test Method for Density of Bituminous Concrete in Place by Nuclear Method.
 - 3. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M140 - Emulsified Asphalt
 - b. M208 - Cationic Emulsified Asphalt
 - c. M320 - Standard Specification for Performance-Graded Asphalt Binder
 - d. T84 - Specific Gravity and Absorption of Fine Aggregate.
 - e. T85 - Specific Gravity and Absorption of Coarse Aggregate.
 - f. T230 - Density of Bituminous Aggregate Mixtures
 - 4. City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012.

1.03 GENERAL:

- A. All pavements shall be hot bituminous pavement of the plant mix type unless otherwise approved in writing by the Owner and/or Engineer. Materials and construction shall be in accordance with the Owner's Standard Specifications and the following requirements:

1.04 SUBMITTALS:

- A. Submit as specified in Thornton's General and Special Conditions.
- B. Mixture designs shall be performed in a materials laboratory under the direct supervision of and shall be stamped and signed by a Professional Engineer (P.E.) licensed in the State of Colorado and practicing in this field.
- C. Mix Design:
 - 1. Contractor shall provide mix designs and prepare a job mix formula (no more than one year old) for each mixture specified. Mix designs shall be accomplished by a qualified, independent, commercial testing laboratory.
 - 2. Furnish seven copies of the proposed job mix formula, including the laboratory test report, to the City of Thornton's Construction Coordinator and Engineer for approval not less than 30 days prior to beginning production of paving mixture. Test reports shall indicate the following:
 - a. Source of materials
 - b. Gradation, specific gravity, source and description of individual aggregates in blend
 - c. Aggregate physical properties
 - d. Source and grade of performance graded binder (PG Binders)
 - e. Proposed job mixes
 - f. Asphalt cement content in percent of total mix by weight.
 - g. Graphic plots of:
 - (1) Density versus asphalt content.
 - (2) Stability versus asphalt content.
 - (3) Percent voids total mix versus asphalt content.
 - (4) Flow versus asphalt content.
 - h. Mixing and compaction temperatures used.
- D. Submit certificates accompanied by a copy of the refinery test report for bituminous materials for:
 - 1. Tack coat.
 - 2. Asphalt cement.
- E. Samples:
 - 1. New asphaltic concrete pavement not meeting non-destructive pavement testing requirements shall be subject to core sampling at the City of Thornton's Construction Coordinator's discretion.
 - 2. Core or saw undamaged Samples from the completed pavement courses at locations designated by the City of Thornton's Construction Coordinator's:
 - a. Core Samples shall be not less than 4-inch diameter.
 - b. Take three Samples from each day's production or from each 300 tons of mixture placed, whichever is the greater number of Samples.
 - c. Deliver Samples to the independent laboratory approved by City of Thornton. Samples may be tested for density and extraction.
 - 3. Replace pavement at Sample location with fresh bituminous mixture and thoroughly compact repaired area.

1.05 TESTING:

- A. Contractor shall, through services of an independent laboratory approved by the City of Thornton’s Construction Coordinator, test asphaltic concrete pavement to determine conformance with Contract Specifications.
 - 1. At the City of Thornton’s Construction Coordinator’s option, asphaltic concrete pavement may be tested to determine conformance with density, gradation, and asphalt content (by extraction).
 - 2. At the City of Thornton’s Construction Coordinator’s option, density may be tested by either of the following methods:
 - a. AASHTO T230.
 - b. ASTM D2950.
- B. Contractor shall perform such other tests as Contractor deems necessary to assure production of asphaltic concrete conforming to specified quality, and in accordance with specification requirements.
- C. Contractor shall test surface smoothness by applying a 10-foot straightedge both parallel and at right angles to the centerline of paved areas:
 - 1. Test at 50-foot maximum intervals, and more frequently when requested by the City of Thornton’s Construction Coordinator.
 - 2. The City of Thornton’s Construction Coordinator will observe straightedge testing.
- D. The frequency of test shall be in compliance with jurisdictional requirements (or as otherwise required by the City of Thornton’s Construction Coordinator).
- E. Method of testing shall be as specified by the governing jurisdiction or the Owner standards, whichever is more stringent.
- F. Removal and replacement of unsatisfactory work shall be completed within 15 days of written notification of the deficiency unless the condition is deemed an emergency requiring immediate correction. In the event the replacement work is not completed within the specified time period, the jurisdictional authority may take action to complete the work and charge the Contractor for all related costs.

1.06 TOLERANCES:

- A. Density of completed pavement shall be not less than the following percentage of the density of the laboratory mix design:
 - 1. First Lift of Base Course: 95%.
 - 2. All Other Courses: 97%.
- B. Surface:
 - 1. Surface shall be of uniform texture and appearance.
 - 2. Smoothness shall be such that variation from a 10-foot straightedge does not exceed the following limits:
 - a. Final Lift of Base Course: 1/2-inch.
 - b. Surface Course: 3/8-inch.

- 1.07 DESIGN INTENT:
- A. The design intent is to provide pavement with adequate thickness and quality to provide a serviceable life of at least twenty (20) years.
- 1.08 BASE COURSE:
- A. This item consists of the foundation course composed of crushed gravel or crushed stone and filler, constructed on the prepared subgrade or subbase course.
 - B. Materials and construction shall be in accordance with Section 32 11 23 - "Crushed Aggregate Base Course."

PART 2 - PRODUCTS

- 2.01 MATERIALS:
- A. General: In addition to the below specifications, all products, materials, and equipment shall meet the requirements of the owning/maintaining authority and/or conform to the City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012, Section 500 - "Street and Parking Facilities Construction."
 - 1. In situations of conflict between this specification and the owning/maintaining authority, the most stringent specification shall apply.
 - B. Equipment and Materials shall conform to the requirements of the Colorado Department of Transportation's (CDOT) *Standard Specifications for Road and Bridge Construction*, current edition.
 - 1. Conform to Section 702 - "Bituminous Materials."
 - 2. Conform to Section 703 - "Aggregates."
 - C. Hot mix asphalt shall be composed of a mixture of aggregate, filler, hydrated lime, and asphalt binder. Top mixes require polymer modified asphalt binder.
 - D. Materials:
 - 1. Bituminous Material:
 - a. Aggregate:
 - (1) Aggregates for hot mix asphalt shall be of uniform quality, composed of clean, hard, durable particles of crushed stone, crushed gravel, or crushed slag.
 - (2) Excess of fine material shall be wasted before crushing.
 - (3) The material shall not contain clay balls, vegetative matter, or other deleterious substances and shall meet the requirement presented in Table 500-7 of the City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012.
 - b. Reclaimed asphalt pavements (RAP):
 - (1) Hot asphalt pavement shall not contain more than 20 percent reclaimed asphalt pavement where allowed. The reclaimed asphalt pavement shall meet the requirements of CDOT subsection 703.04.
 - c. Mineral Filler:
 - (1) Contractor shall submit hydrometer analysis (AASHTO T88) for the gradation of mineral filler use in HMA mixture.
 - d. Asphalt Cement:

- (1) Asphalt binder shall meet the requirements of the Superpave Performance-Graded Binders (PG) as presented in Table 500-10 of the City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012:
- (2) The following asphalt cement qualities are required for all pavements:

Course	Binder Grade	Gyratory design revolutions N_{design}	Minimum Hveem Stability (min.)
Final (Top) Course	PG 76-28	100	30
Bottom Courses	PG 64-22	75	30

- e. Hydrated Lime (Additive):
 - (1) Lime shall be added at the rate of one percent (1%) by dry weight of the aggregate and shall be included in the amount of material passing the No. 200 sieve. Hydrated lime for aggregate pretreatment shall conform to the requirements of ASTM C 207, Type N. In addition, the residue retained on a 200-mesh sieve shall not exceed ten percent (10%) when determined in accordance with ASTM C 110. Drying of the test residue in an atmosphere free from carbon dioxide will not be required.
- f. Tack Coat:
 - (1) Materials and construction shall be in accordance with the requirements of the CDOT Standard Specifications, Section 407.
 - (2) Bituminous material shall be SS-1H emulsion, diluted by mixing three (3) gallons of SS-1H emulsion with one (1) gallon of clean water, applied at the rate of 0.10 gallons per square yard.
2. Asphaltic Concrete Mixture:
 - a. See City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012, Table 500-8 for grading requirements.
 - b. Mixtures:
 - (1) Bottom Courses: Hot bituminous pavement Grading S.
 - (2) Top Course: Hot bituminous pavement Grading SX.
 - c. Design air voids = 3.5% to 4.5%, target of 4.0%.
 - d. At least 90% of the aggregate retained on the No. 4 sieve shall have at least two mechanically induced fractured faces.

- e. Minimum Voids in the Mineral Aggregate (VMA) shall be according to the following table (interpolate values as needed):

Nominal Maximum Size	Design Air Voids		
	3.5%	4.0%	4.5%
1	12.2	12.7	13.2
3/4	13.2	13.7	14.2
1/2	14.2	14.7	15.2
SMA	17.0	17.0	17.0

- 1. Nominal maximum particle sized is defined as one sieve size larger than the first sieve to retain more than 10% but shall not exceed the 100% passing size. The nominal maximum particle size can vary during mix production even when the 100% passing size is constant.
- 2. Minimum VMA criteria shall be linearly interpolated based on actual air voids.
- f. Voids Filled with Asphalt (VFA) shall be minimum 65% to 80%.
- g. Tensile Strength Ratio: ≥ 75

- E. All vertical and horizontal asphalt surfaces abutting the asphalt shall have a tack coat applied.
- F. Temporary Patching:
 - 1. Minimum requirements for temporary patching material shall be well-compacted surfacing material conforming to “Road Mixed Asphalt Surfacing Material” of the CDOT Standard Specifications.
 - 2. Patching material shall match flush with the existing pavement surface and shall not be less than 4 inches thick.
 - 3. The mineral aggregate shall conform to the grading specified for 3/8-inch maximum aggregate 5 percent.
 - 4. Asphalt binder to be mixed with the mineral aggregate shall be liquid asphalt, Grade MC-3000, and shall be an amount between 5.5 percent and 6 percent by weight of the dry mineral aggregate.

PART 3 - EXECUTION

3.01 GENERAL:

- A. In addition to the below specifications, all construction requirements shall follow those of the owning/maintaining authority or conform to the City of Thornton’s *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012, Section 500 - “Street and Parking Facilities Construction.”
- B. In situations of conflict between this specification and the owning/maintaining authority’s standards, the most stringent specification shall apply.
- C. Private roadways:
 - 1. Consult local owning/maintaining authority.
- D. Protect roadway from solvents and oils that may be potentially deleterious to the new and existing asphalt. Asphalt damaged by solvents and oils shall require repair and the cause of the damage shall be removed from the Site until preventative measures have been taken to prevent further harm.

3.02 TEMPORARY PATCHES:

- A. When the final surface is not immediately installed, it shall be necessary to place a temporary asphalt surface on any street cut opening immediately after backfilling. The temporary surface installation and daily maintenance shall be the responsibility of the Contractor until the permanent surface is completed and accepted. The temporary surface shall be either a hot mix or cold mix paving material. Temporary surfaces shall be compacted, rolled smooth, and sealed to prevent degradation of the repair and existing structures during the temporary period.
- B. Trenches within roadways shall be backfilled or covered with steel plates of appropriate strength at the conclusion of the work done in order to open the roadway to traffic. Asphalt material shall be placed at the edges of the plate to provide a ramp at a minimum 1:12 slope. Steel plates shall be placed such that traffic will not cause them to move.
- C. Permanent patching shall occur within 2 weeks unless approved in advance by the local jurisdiction. The temporary patch shall be removed prior to placement of the permanent patch.

3.03 PAVEMENT REMOVAL AND REPLACEMENT:

- A. Removal:
 - 1. Lay out area to be removed in neat, straight lines parallel to longitudinal centerline of trench.
 - 2. Existing pavements should be removed to clean, straight lines parallel or perpendicular to the flow of traffic. Patches shall not be constructed with angled sides or irregular shaped edges.
 - 3. Minimum of twenty-four inches (24") beyond limit of anticipated excavation for pipe, structures and appurtenances.
 - 4. Extend area to existing pavement joints or edge of pavement where cut would result in the remaining pavement strip being less than 6 feet in width.
 - 5. Cut pavements full depth to obtain straight cuts with smooth vertical faces.
 - a. Make cuts prior to breaking.
 - b. Use approved power-driven saw on Portland cement and asphaltic concrete pavements.
 - c. Repeat after backfill of trench as required to provide adequate shear stress overcuts as shown on the Contract Drawings.
 - 6. Repeat after backfill of trench as required to remove undermined, heaved, or otherwise damaged surfaces or edges.
 - 7. Dispose of materials off the Project Site at a location arranged and paid for by the Contractor.
- B. Replacement:
 - 1. Replace pavements and surfacing of highways, streets, roads, drives, and sidewalks with like materials.
 - 2. Complete within two (2) weeks' time of pipe installation, weather permitting.
 - 3. Include replacing base materials to original grade and density prior to placing surface course.
 - 4. Asphalt replacement shall be consistent with the applicable owning/maintaining authority.
 - 5. Restore pavement to condition equal to or better than condition before start of work.

6. Restore to satisfaction of the governing agency.
 7. Replace existing asphalt with a minimum thickness to match the original asphalt thickness
 8. Patches within existing patches are to be avoided. Where this cannot be avoided, boundaries of the new patch shall match the existing patch.
 9. Where three or more pavement cuts are proposed within a 75-foot-long roadway section, the pavement between the patches shall be milled and inlaid with new pavement over the entire work area. In cases where the existing pavement is in poor condition and may require overlay within the next few years, this requirement may be modified or waived by the local jurisdiction.
 10. Transverse patch lengths shall extend across the full width of the travel lane. Minimum width for transverse patches shall be 10 feet.
 11. Edges of patches shall not fall in existing wheel paths. The edges of patches parallel to the direction of traffic shall be limited to the boundaries of lanes or to the centerline of travel lanes. For bicycle lanes, the cut shall be at the line or the edge of the gutter.
 12. Patches should have a smooth longitudinal grade consistent with the existing roadway. Patches should also have a cross slope or cross section consistent with the design of the existing roadway. The width of patches shall be consistent to simplify future maintenance.
 13. The thickness of asphalt patches in asphalt streets shall equal the thickness of the existing asphalt plus 1-inch.
- C. Base Course:
1. Base course shall be equal to existing but not less than 8-inches unless otherwise specified.

3.04 PRE-PAVING MEETING:

- A. Contractor shall conduct a pre-paving meeting a minimum of two (2) weeks prior to the proposed installation of hot mix asphalt.

3.05 HAULING:

- A. Each delivery truck shall use full covers (tarps) to completely protect the mix during transport at all times. The City of Thornton's Construction Coordinator can reject any mix which shows deficiency of asphalt damage due to burning or overheating, improper gradation, or thermal segregation with cold areas below the minimum discharge temperature.

3.06 TACK COAT:

- A. All vertical and horizontal asphalt surfaces abutting the asphalt shall have a tack coat applied.
- B. Apply tack coat to the surface of all existing pavement and all previously placed asphaltic concrete pavement lifts or courses before placing the succeeding lift. Tack coat shall be worked into the roadway surface by use of rubber-tired equipment.
- C. Apply at the following rates:
 1. Dilute with 3:1 emulsion to water and apply at 0.10 +/- 0.01 gallons per square yard of diluted material.

3.07 PLACEMENT:

- A. Hot mix asphalt shall be placed only on approved, properly constructed surfaces that are free from loose material, water, frost, snow or ice. The hot mix asphalt and tack coat shall be placed in accordance with the temperature limitations of City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012, Table 500-16 and 500-17 and only when weather conditions permit the pavement to be properly placed and finished as determined by the City of Thornton's Construction Coordinator. Placement temperature as stated shall be increased by 5° F for each 10 miles per hour wind velocity to a maximum increased minimum placement temperature of 70 ° F.
- B. The mixture shall not be placed at a temperature lower than 245° F for mixes containing PG 58-28 or PG 64-22 asphalt, and 290° F for mixes containing polymer modified asphalt binder. Mix which is too cold or damaged by weather will be rejected.
- C. The mixture shall be placed on an approved surface, spread and struck off to obtain the required grade and elevation after compaction. The minimum lift thickness shall be at least 3 times (preferably 4 times) the nominal particle size. The un-compacted mixture should be placed approximately 10-25 % thicker than the existing surrounding mat to account for compaction based on the materials being placed. Raking is discouraged and will not be allowed except to correct major problems of grade and elevation. Casting or raking that causes any segregation will not be permitted.
- D. Asphalt must be placed with a self-propelled paver conforming with the requirements specified in CDOT Specifications Section 401.1 if patching widths are greater than 8 feet. For patch widths greater than 4 feet and up to 8 feet, the mixture must be placed with either a self-propelled paver or a box spreader. These machines may be used to patch areas wider than 8 feet with the use of a screed extension that will extend beyond the width of the proposed patch.
- E. Areas wider than the machine screed may be patched with a box spreader only if the length of the patch is less than 50 feet. Areas as wide as the street or longer than 50 feet shall be patched with an asphalt lay down machine.
- F. Rollers:
 - 1. Rollers shall move at a uniform speed with the drive roll or wheels nearest the paver.
 - 2. Steel-wheeled rollers shall operate at a maximum speed of 3 mph.
 - 3. The use of plate type compactors will not be permitted except in areas not accessible to the roller.
- G. On areas where the use of mechanical spreading and finishing equipment is impracticable, the mixture shall be carefully dumped, spread, raked, screeded, and luted by hand tools to the required compacted thickness plus approximately 25 % based on the materials being placed. Carefully move or minimally work the HMA mix with the use of rakes, lutes, or shovels to avoid segregation. Mixtures made with modified asphalt binder require more rapid completion of handwork areas than for normal mixtures. Hauling and placement sequences shall be coordinated so that the paver is in constant motion. Excessive starting and stopping shall not be allowed. A construction joint shall be placed any time the paver stops, and the screed drops enough to cause a surface dip in violation of Section 504.13, Production Tolerances; or the mat temperature falls below that allowed in Section 504.12, Compaction. Bituminous pavers shall be used to

distribute the mixture either over the entire width or over such partial width as may be practicable. Echelon paving will be permitted.

- H. After placing the new asphalt, all seams (joints) between the new and existing pavements shall be sealed with an asphalt tack coat or rubberized asphalt sealant.

3.08 OVERLAYS:

- A. In streets where more than one cut is made within a 75-foot long roadway segment, an overlay of the entire street width, including the patched area shall be required.
- B. There shall be no feathered edges on any type of street. When edge of existing pavement adjoins gutter, overlays should be placed by first removing the edge of existing pavement to the desired depth by grinding and then replacing the pavement with an asphalt lay down machine. Grinding shall be to a depth such that the top of overlay is no more than 1/4-inch from the top of the gutter lip.
- C. Overlaying layers of asphalt shall not be placed until the lower layer has cooled sufficiently to provide a stable material that will support the equipment without rutting, shoving, or moving in any manner. All paving on each street shall be completed in one continuous operation, weather permitting, unless otherwise approved in writing by the Local Entity Engineer.
- D. The Contractor shall schedule the work so that no planed or recycled surface is left without resurfacing for more than 10 calendar days between October 1 and March 1.
 - 1. The Contractor shall immediately place a temporary hot asphalt pavement layer on any surface that has been planed or recycled and cannot be resurfaced in accordance with the above temperature requirements within 10 calendar days after being planed or recycled. The minimum thickness of the temporary hot asphalt pavement layer shall be 2 inches.
 - 2. The Contractor shall perform the quality control (QC) required to assure adequate quality of the hot asphalt pavement used in the temporary layer. All applicable pavement markings shall be applied to the temporary layer surface.
 - 3. The Contractor shall maintain the temporary layer for the entire period that it is open to traffic. Distress that affects the ride, safety, or serviceability of the temporary layer shall be immediately corrected to the satisfaction of the Local Entity Engineer. The temporary hot asphalt pavement layer shall be removed when work resumes.

3.09 TOP LIFT SURFACE TOLERANCES:

- A. The surface variation between any 2 contacts shall not exceed 3/16-inch in 10 feet for full lane width paving. For patching surface tolerances, the variation shall not exceed 3/8-inch in 10 feet. Irregularities exceeding the specified tolerance shall be corrected at the Contractor's expense. Transverse measurements for variations shall exclude breaks in the crown sections.

3.10 BASE COURSE:

- A. Place to densities described in Section 32 11 23 - "Crushed Aggregate Base Course" and to the dimensions shown on the Contract Drawings.

3.11 PERMITS TO OPEN SURFACES:

- A. Obtain permits to open surface from the agencies having jurisdiction prior to cutting any streets.
- B. Post bond and pay any fees or license as required.

3.12 FIELD QUALITY ASSURANCE (QA):

- A. See Section 1.05.
- B. Damage:
 - 1. If pavement adjoining the original pavement cut is damaged during construction, it shall be removed with and repaired after backfilling at no cost to the Owner.

END OF SECTION 32 12 16

SECTION 32 16 00 - CURBS, GUTTERS, SIDEWALKS, AND DRIVEWAYS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes:
 - 1. Concrete curbs, gutters, sidewalks, median, and paved drainage where indicated.
 - 2. Asphalt and concrete private driveway and entrances where indicated.
- B. The following requirements apply to the construction of a private driveways and entrances, subject to conditions indicated on the drawing.
 - 1. Vehicular access to all private driveways shall be maintained throughout the Contract except during the specified periods described below.
 - 2. Close private driveways one time for a period not to exceed eight (8) hours for any driveway if required to perform construction. However, means shall be provided to allow owner's access to their property at all times.
 - 3. One driveway shall remain open at all times where property abutting the Project is served by two or more separate driveways.
 - 4. Vehicle tracking pads shall conform to the governing jurisdiction's detail and shall be installed at all locations where construction vehicles will be entering paved roads from unpaved areas.
- C. Related Work Specified Elsewhere:
 - 1. Section 31 20 50 - "Site Preparation and Earthwork."
 - 2. Section 32 12 16 - "Asphaltic Paving."

1.02 REFERENCES:

- A. Applicable Standards:
 - 1. American Concrete Institute (ACI):
 - a. 306 - Cold Weather Concreting.
 - b. 305 - Hot Weather Concreting.
 - 2. ASTM International (ASTM):
 - a. A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - b. C309 - Liquid Membrane-Forming Compounds for Curing Concrete
 - c. C920 - Elastomeric Joint Sealants
 - d. D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - e. D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - 3. Federal Specifications (FS):
 - a. TT-S-00227 - Sealing Compound; Elastomeric Type, Multi-Component. (For caulking, sealing, and glazing in buildings and other structures.)
 - 4. City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012.

1.03 WEATHER LIMITATIONS:

- A. Conform to ACI 306 when temperature is below 40°F, or is likely to fall below 40°F within a 24-hour period after placement of concrete.
- B. Conform to ACI 305 when temperature is above 100°F, or is likely to rise above 100°F within a 24-hour period after placement of concrete.

PART 2 - PRODUCTS

2.01 GENERAL:

- A. General: In addition to the below specifications, all products, materials, and equipment shall meet the requirements of the owning/maintaining authority.
- B. In situations of conflict between this specification and the owning/maintaining authority, the most stringent specification shall apply.

2.02 CONCRETE:

- A. See City of Thornton Standards and Specifications (Rev Oct 2012) Section 600

2.03 CRUSHED ROCK:

- A. See Section 32 11 23 - "Crushed Aggregate Base Course."

2.04 ASPHALT:

- A. See Section 32 12 16 - "Asphaltic Paving."

2.05 JOINT DOWELS:

- A. Smooth round dowels having at least one-half the length of each dowel coated to ensure that no bond is developed between dowel and concrete.
- B. Conform to ASTM A615 Grade 60.

2.06 EXPANSION JOINT FILLER:

- A. Prefomed material cut and shaped to the required cross section.
- B. Thickness of 1/2-inch unless otherwise indicated.
- C. Conform to ASTM D1751 for all expansion joints except for those in sidewalks. Conform to ASTM D1752, Type II or Type III, for expansion joints in sidewalks.

2.07 JOINT SEALER:

- A. Conform to ASTM C920, Type M, Grade P, Class 25, use TMO for all joints required to be sealed except those in sidewalks. Color as approved by Owner and/or Engineer.
- B. For Expansion Joints in Sidewalks:
 - 1. Conform to FS TT-S-00227.
 - 2. Nontracking after initial cure.
 - 3. Two-component, cold-applied.
 - 4. Compatible with preformed expansion joint filler.
 - 5. Gray color.

2.08 CURING COMPOUND:

- A. Conform to ASTM C309, Type I or Type I-D.

- 2.09 FORMS:
- A. Wood or metal.
 - B. Straight and strong enough to resist springing during placement of concrete.
 - C. Sufficient bearing surface to prevent tipping.
 - D. Height equal to full depth of section to be constructed.
- 2.10 SLIP-FORM MACHINE:
- A. Designed to produce finished concrete items true to line, grade, and cross section.
 - B. Designed to extrude and compact concrete by means of extrusion form accurately shaped to the required cross section.
 - C. Line and grade controlled automatically from erected taut wire or string line.
 - D. Equipped with trailing side form when necessary to support material behind the extrusion plate.
 - E. Equipped with finishing devices to produce type of finish specified.

PART 3 - EXECUTION

- 3.01 GENERAL
- A. In addition to the below specifications, all construction requirements shall meet that of the owning/maintaining authority.
 - B. In situations of conflict between this specification and the owning/maintaining authority, the most stringent specification shall apply.
- 3.02 PREPARATION:
- A. Subgrade preparation is as specified in Section 31 20 50 - "Site Preparation and Earthwork."
 - B. Aggregate Base Course as specified in Section 32 11 23 - "Aggregate Base Course."
- 3.03 INSTALLATION:
- A. Perform all concrete work in accordance with City of Thornton Standards and Specifications (Rev Oct 2012) Section 600, and as follows:
 - B. Forms
 - 1. Use flexible forms for all curved form lines except:
 - a. Curves having a radius of 200 feet or greater may be formed in 10-foot or shorter chords.
 - b. Curves having a radius of 100 feet or greater may be formed in 5-foot or shorter chords.
 - 2. Thoroughly clean, oil, securely stake, brace, and hold forms to line and grade.
 - 3. Remove forms from front face of curb section at the time necessary to permit finishing concrete. Leave other forms in place not less than 12 hours after placement of concrete.
 - C. Joints:
 - 1. Contraction Joints:
 - a. Construct at locations indicated and as follows:
 - (1) Divide concrete curb, curb and gutter, median, and paved drainage into monolithic sections not greater than 10 feet in length.

- (2) Match contraction joint spacing of adjacent Portland cement concrete pavement.
 - (3) Divide detached sidewalks into approximately square areas.
 - b. Form contraction joints by the following methods:
 - (1) Place 1/8-inch thick steel separators after concrete has taken its initial set, but before final finishing.
 - (2) Cut a groove in the fresh concrete to a depth of at least one-fourth the section thickness by use of a jointer having a radius of 1/8-inch and thickness not exceeding 1/8-inch.
 - (3) Saw the hardened concrete before shrinkage cracking occurs. Depth of cut not less than 1/4 the section thickness and width of key not to exceed 3/16-inch.
 - 2. Expansion/Isolation Joints:
 - a. Construct at the following locations:
 - (1) Locations as indicated.
 - (2) All points of curvature and points of tangency of curves having a radius of 100 feet or less, and at intervals not exceeding 60 feet in tangent section.
 - (3) Locations matching expansion joint spacing of adjacent Portland cement concrete pavement.
 - (4) Locations where curb, curb and gutter, sidewalk, median, or paved drainage about each other or other structures and slabs.
 - (5) Every 500 feet in long runs
 - b. For expansion joints, stake, support, and secure local transfer dowels and preformed joint filler in position to prevent displacement during placing and finishing operations.
 - c. Round edges of joints with an edging tool of 1/4-inch radius.
 - 3. Key Joints: Construct at locations indicated for paved drainage and curb and gutter adjacent to Portland cement concrete pavement.
 - 4. Construction Joints:
 - a. Locate to coincide with contraction, expansion, or key joints.
 - b. When concrete placement is interrupted between joint locations for a sufficient time for the concrete to take its initial set, remove concrete to the nearest joint location before resuming placement.
 - c. Make transverse construction joints in paved drainage having a thickness of 6 inches or greater by either key joints or doweled joints.
- D. Concrete:
- 1. Placing Concrete:
 - a. Place only on prepared and approved subgrade.
 - b. Lightly moisten surface of dry subgrade before placing concrete.
 - c. Deposit and compact concrete in manner to avoid displacement of forms and joint materials.
 - d. Tamp or vibrate concrete sufficiently to eliminate all voids and bring the mortar to the top for finishing.
 - 2. Finishing Concrete
 - a. Edge concrete with proper edging tools.
 - b. Tool radii as soon as possible after concrete has taken its initial set.
 - c. Remove curb face forms and rub with rubbing block and water until all blemishes, forms, and tool marks have been removed.

- d. Float-finish with wood float or concrete rubbing block until concrete is true to line, grade, and cross section, and is uniform in texture.
 - e. Brush with hairbrush as follows:
 - (1) Curb and gutter parallel to the line of curb.
 - (2) Sidewalk and median perpendicular to their longitudinal axis.
 - f. Do not use mortar topping or sand and cement dryer.
- E. Tolerances:
- 1. Applies to conventional and slip-form construction.
 - 2. Alignment deviation of finished concrete Work not to exceed 1/4-inch in 10 feet from true line and grade.

3.04 SLIP-FORM CONSTRUCTION:

- A. Prepare subgrade a sufficient additional width as necessary to provide support and tracking for the slip-form machine.
- B. Adjust slump (reduce) and control concrete mix as necessary to provide satisfactory slip-form construction.
- C. Use supplementary hand-finishing operation when necessary to produce uniform finishes free from blemishes and of the types and textures specified.

3.05 CONCRETE CURING AND PROTECTION:

- A. Curing:
 - 1. Spray all exposed surfaces after finishing with curing compound.
 - 2. Apply curing compound at a rate of not less than 1 gallon per 25 square yards of surface area, or as recommended by manufacturer.
 - 3. Apply second coat at a rate of not less than 1 gallon per 30 square yards 30 minutes after first-coat application when the atmospheric temperature exceeds 100°F, or as recommended by manufacturer.
- B. Protection:
 - 1. Protect the finished Work from damage until final acceptance.
 - 2. Repair, replace, or clean all concrete damaged or discolored prior to final acceptance.
 - 3. For areas exposed to vehicular traffic, the concrete shall be protected until 80% of required concrete strength is achieved.

3.06 SEALING JOINTS:

- A. Seal all expansion joints and contraction joints 1/4-inch or greater in width.
- B. Do not seal portions of expansion joints located in vertical parts of curbs.
- C. Remove curing compound and other material from joint surfaces before sealing. Joint shall be clean and surface dry at time of sealant application.
- D. Apply joint sealant using methods and equipment necessary to ensure complete filling of the joint space without voids or air bubbles.
- E. Apply sealant to conform to sealant manufacturer's instructions.
- F. Apply finished sealant from 1/8-inch below to level with adjacent concrete surfaces.
- G. Protect adjacent surfaces to prevent contamination with sealant material.
- H. Protect sealant until it has set up or cured sufficiently to preclude pickup or tracking.

3.07 SIDEWALK REPLACEMENT:

- A. Replace sidewalks with like materials, similar materials, and identical jointing.
- B. Concrete shall be removed to edges that are neatly sawed to a minimum of one-half the concrete thickness. Sidewalks and driveways shall be saw cut in straight lines either parallel to the curb or perpendicular to the alignment of the sidewalk or curb.
- C. No concrete section to be replaced shall be less than 5 feet in either width or length for a driveway or crossspan, and 5 feet in length, for sidewalk, curb, and gutter.
- D. Match existing construction and restore to condition equal to or better than condition before start of Work.
- E. Restore to satisfaction of the governing agency.
- F. Equal existing width and thickness but not less than 4 feet wide nor 6 inches thick.
- G. Score contraction joints at 4-foot intervals and place expansion strip where new sidewalks abut existing walks, drives, curbs, or similar structures.
- H. All work must meet ADA requirements.

3.08 PRIVATE DRIVEWAYS AND ENTRANCES:

- A. Location:
 - 1. The Contractor shall place 4 inches of temporary crushed rock surfacing or permanent patch along the excavation to maintain vehicular access during the period of time between the first closure for trenching and grading and the second closure for construction of the permanent driveway pavement.
 - 2. The Contractor shall add crushed rock, shape, and maintain temporary crushed rock driveway as directed by the City of Thornton's Construction Coordinator.
 - 3. Driveways are to be restored to better or equal to pre-construction conditions.
- B. Coordination:
 - 1. The Contractor shall notify the City of Thornton's Construction Coordinator and owner/tenant of each driveway to be affected by temporary closure not less than 48 hours prior to closure to provide the owner/tenant reasonable opportunity to make arrangements for temporary removal of vehicle or modify plan of operation.
- C. Construction:
 - 1. Place crushed rock to uniform depth of 4 inches over the entire area to be surfaced.
 - 2. Permanent asphalt replacement as specified in Section 32 12 16 - "Asphaltic Pavement."
 - 3. Permanent concrete replacement as specified in this Section and Section 32 16 00 - "Curbs, Gutters, Sidewalks, and Driveways."

END OF SECTION 32 16 00

SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes pavement markings for the following areas:
 - 1. Roads and streets.
- B. The Contractor shall renew or replace any existing traffic striping and/or pavement markings, which have been either removed, or the effectiveness of which has been reduced during construction operations.
 - 1. Temporary markings are required until the permanent marking are replaced.
 - 2. Centerline marking shall be replaced each day after construction is complete.
 - 3. Renewal of pavement striping and marking shall be done in conformance with local jurisdiction's standard specifications.
- C. Restoration or replacement of all pavement markings shall be restored to the type, dimensions, and color of those destroyed unless indicated otherwise.
- D. Pavement marking plans shall include but are not limited to:
 - 1. Crosswalks
 - 2. Exclusive right-turn lanes
 - 3. Exclusive left turn lanes
 - 4. Edge lines
 - 5. Stop bars
 - 6. White skip lines
 - 7. Solid double yellow lines
 - 8. Yellow skips
- E. The Contractor shall be responsible for the removal of any existing pavement markings necessary to install new marking for the Project.
- F. The work consists of furnishing and applying pavement markings in accordance with these specifications, the Manual of Uniform Traffic Control Devices for Streets and Highways (MUTCD), the Colorado supplement thereto, and in conformity to the lines, dimensions, patterns, locations, and details shown on the Contract Drawings or established.
- G. Pavement Marking Layout:
 - 1. The Contractor will layout pavement marking locations prior to installation
 - a. Before installation, the lines must be approved by the City of Thornton's Construction Coordinator and the governing agency.
- H. In general, paint will not be used for permanent markings unless approved by the Owning agency. On existing or new pavements, either Preformed Thermoplastic or Hot Extruded Thermoplastic Pavement Markings shall be used.
- I. Related Work Specified Elsewhere:
 - 1. Standard Specifications: Section 01 55 26 - "Traffic Control."

1.02 REFERENCES:

- A. Applicable Standards:
 - 1. Colorado Department of Transportation (CDOT):
 - a. Standard Specifications for Road and Bridge Construction, current edition.
 - 2. American Association of State Highway and Transportation Officials (AASHTO):

- a. M247 - Standard Specification for Glass Beads Used in Pavement Markings
- 3. City of Thornton's Standards and Specifications for the Design and Construction of Public and Private Improvements, October 2012.

1.03 SUBMITTALS:

- A. Submit as specified in Thornton's General and Special Conditions.
- B. Includes, but not limited to, the following:
 - 1. Temporary striping paint.
 - 2. Permanent striping Preformed Thermoplastic.
 - 3. Reflective glass beads product data and application rates.
 - 4. Thermoplastic product data and installation equipment and procedure. Thermoplastic products may be utilized as an alternative for permanent markings.
 - 5. Product data and label analysis on marking paint.

1.04 DELIVERY AND STORAGE:

- A. Deliver all paint materials to the Site in original unopened containers with labels intact and legible.
- B. Store as recommended by the manufacturer.

PART 2 - PRODUCTS

2.01 TEMPORARY PAVEMENT MARKINGS:

- A. Temporary pavement markings necessary to facilitate construction (i.e., detours or temporary lane markings) may be installed using paint.

2.02 PERMANENT PAVEMENT MARKINGS:

- A. Prefabricated legends and symbols shall conform to the applicable shapes and sizes as outlined in the MUTCD.
- B. Continuous lane markings and centerline markings required to be installed as a result of new construction shall be Preformed or Hot Thermoplastic Pavement Markings with a minimum thickness of 90 mils.
- C. Special Pavement Markings (turn arrows, stop bars, etc.) required to be installed as a result of new construction shall be thermoplastic as per CDOT Specification 627.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

- A. Clean surface dry, smooth, and free of dust, oil, grease, and frost.

3.02 TEMPORARY PAVEMENT MARKINGS:

- A. Apply temporary, painted markings if permanent pavement parking is unavailable or not constructible
 - 1. Apply during cold weather until air temperatures allow for permanent markings.
- B. Apply immediately following construction any disturbance to existing lane markers.

3.03 PAVEMENT MARKING:

- A. All pavement markings shall be installed per CDOT specification 627.06 and City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012.
- B. Thermoplastic Pavement Markings:
 - 1. Apply markings where indicated, including direction arrows, handicapped symbols, and other indicated symbols or wording.
 - 2. Apply under dry and dust-free conditions.
 - 3. Apply with ambient and pavement temperature not less than 50°F.
 - 4. Protect pavement marking from traffic until pavement marking has dried sufficiently to prevent tracking.
 - 5. Apply to a thickness of not less than 3/32-inch at the edges, or less than 1/8-inch at the center.
 - 6. Glass beads shall be applied to the thermoplastic pavement marking at a rate of 10 pounds per 100 square feet, minimum.

END OF SECTION 32 17 23

SECTION 32 91 05 - TOPSOILING AND FINISHED GRADING

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes Topsoiling and Finished Grading activities.
- B. Related Work Specified Elsewhere:
 - 1. Section 31 20 50 - "Site Preparation and Earthwork."
 - 2. Section 32 92 00 - "Seeding."

1.02 SUBMITTALS:

- A. Submit as specified in Thornton's General and Special Conditions.

1.03 PROJECT CONDITIONS:

- A. Verify amount of topsoil stockpiled and determine amount of additional topsoil, if necessary to complete work.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Topsoil:
 - 1. General: Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inch maximum dimension, and free of subsoil, roots, grass, noxious weeds, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.
 - 2. Organic Matter Minimum 2.5 percent dry weight as determined in accordance with United States Bureau of Reclamation 514.8.7.
 - 3. pH Range: 4.5 to 8.5.
 - 4. Existing topsoil stockpiled under Sections 31 20 50 - "Site Preparation and Earthwork" and 31 23 16 - "Excavation and Filling for Structures."
 - 5. Capable of supporting native plant growth.
- B. Soil Sterilant:
 - 1. Sterilant shall be Krovar as manufactured by E. I. du Pont de Nemours and Co.

2.02 TOLERANCES:

- A. Finish Grading Tolerance: 0.1 FT plus/minus from required elevations.

2.03 TOPSOIL AMENDMENT:

- A. Topsoil shall be amended prior to placement as follows:
 - 1. Organic soil amendment material for seed and lawn areas shall be a blend of composted manure and aspen humus, nitrolyzed aspen humus, or other material approved by the City of Thornton's Construction Coordinator. Material shall be screened and free from lumps, stones, plant material, and debris, and other material harmful to plant life. Soil amendment material shall meet the following organic/chemical analysis:

Organic Matter Content (%)	50-80
pH Range	6.0-7.2
Ammonia Nitrogen (ppm)	500 (max.)
Salt Content (saturated paste extract, mmhos/cm)	5.0 (max.)
Carbon:Nitrogen Ratio	15-30

- a. Submit a one gallon sample and laboratory analysis to the Construction Coordinator at least 14 days prior to site delivery. Obtain approval of submittals prior to site delivery. Submit all load tickets to the Construction Coordinator prior to installation, verifying source and quantity of material delivered to Site.
- 2. Starter Fertilizer:
 - a. At a minimum, granular diammonium phosphate (18-46-0) shall be applied at a rate of 5 pounds per 1,000 square feet. Additional fertilize supplements shall be determined as follows
 - (1) Prior to any application of fertilizer, a soil analysis shall be performed for a minimum of each 50,000 square feet to be fertilized at the Contractor's expense by a qualified agricultural testing lab approved by the City of Thornton's Construction Coordinator.
 - (2) Samples for testing shall be acquired using a coring tool to take representative samples to a depth of at least 6 inches.
 - (3) The fertilizer applied shall be in the formulation and at the rate recommended in the soil analysis for the intended crop and approved by the City of Thornton's Construction Coordinator.

PART 3 - EXECUTION

3.01 TOPSOILING:

- A. Includes placement of topsoil on all areas not specified to receive paving or other surface treatment (including borrow or waste areas).
- B. Contractor must strip and stockpile topsoil separately for each individual property owner. No topsoil shall be mixed between different property owners.
- C. Materials:
 - 1. Those obtained from excavation which are most suitable and stockpiles for such purpose:
 - a. Topsoil shall be a fertile, friable, and loamy soil of uniform quality, free from materials such as hard clods, stiff clay, stone with any dimension greater than 1-inch, and similar impurities. Relatively free from grass, roots, weeds, and other objectionable plant material.
 - 2. Borrow when required.
- D. Subgrade Treatment:
 - 1. Clear Site of vegetation heavy enough to interfere with proper grading and tillage operations.
 - 2. Clear surfaces of all stones or other objects larger than 2 inches in thickness or diameter, all roots, brush, wire, grade stakes, or other objectionable material.

3. Loosen subgrade by discing or scarifying to a depth of 24 inches wherever compacted by traffic or other causes to permit bonding of the topsoil to the subgrade.
- E. Placement of Topsoil:
1. Distribute over required areas without compaction in upper 1-foot, other than that obtained with spreading equipment.
 2. To extent material is available within following limits:
 - a. Not less than 12 inches in depth.
 - b. Do not exceed 2 feet in depth.
 - c. Shape cuts, fills, and embankments to contours indicated.
 - d. Grade to match contours of adjacent areas and permit good, natural drainage. Provide gentle mound over trenches.
 - e. Provide soil amendments as specified in Part 2 of this specification.
- F. Maintenance:
1. After topsoil has been spread, clear surface of roots, stumps, and stones or other objects equal to or larger than 2 inches in thickness or diameter and all other objects that might interfere with planting and maintenance operations, unless otherwise approved by the City of Thornton's Construction Coordinator at specific locations where larger objects already exist in the topsoil.
 2. Protect topsoiled areas from the elements until grass is established and repair eroded areas as required.
 3. Keep paved areas clean. Promptly remove topsoil or other dirt dropped upon surfacing.

3.02 ACCEPTANCE:

- A. Upon completion of topsoiling, obtain the City of Thornton's Construction Coordinator's acceptance of grade and surface.
- B. Make test holes where directed to verify proper placement and thickness of topsoil.

END OF SECTION 32 91 05

SECTION 32 92 00 - SEEDING AND SODDING

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes the following areas of Work:
 - 1. Preparation of seeded areas.
 - 2. Seeding.
 - 3. Sodding.
 - 4. Mulching.
 - 5. Erosion Control Blanket.
 - 6. Reseeding as necessary before Initial Acceptance and during 1 year maintenance warranty period.
 - 7. Disturbed areas in the reservoir below elevation 5,034 feet (5,034') do not need to be seeded.
- B. Related Work Specified Elsewhere:
 - 1. Section 31 20 50 - "Site Preparation and Earthwork."

1.02 REFERENCES:

- A. Applicable Standards:
 - 1. ASTM International (ASTM) - Equivalent AASHTO standards may be substituted as approved:
 - a. D977 - Emulsified Asphalt.
 - 2. City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012.
 - 3. City of Thornton Specification on Design of Irrigation Systems on City and Public Properties.

1.03 DEFINITIONS:

- A. Construction Maintenance Period: Begin maintenance immediately after each area is planted and continue until issuance of a Certificate of Substantial Completion.
- B. Areas to Be Seeded: All areas disturbed during construction except those areas to be covered with slope protection, aggregate or other surfacing.
- C. Seeding Period: Perform between March 15 and June 15 under favorable weather and soil moisture conditions for this approved seed mix.
- D. Final Acceptance: May occur one (1) year after Initial Acceptance when a healthy, uniform stand of the specified grasses has been established at minimum three to five leaf stage, free of weeds and surface irregularities with minimum 80% grass cover over any 10 square feet in area and bare spots not exceeding 10" by 10".

1.04 SUBMITTALS:

- A. Shop Drawings:
 - 1. Sequence and limits of site reclamation.
 - 2. Proposed method and equipment for hydraulic seeding of slopes steeper than four horizontal to one vertical (4H:1V).
 - 3. Proposed source and materials for soil amendment, fertilizer, seed, and mulch.
- B. Quality Control (QC) Submittals:

1. Soil amendment certifications:
 - a. Mycorrhizae: Produce lists spores/pound.
 - b. Biosol: Fungal and bacterial produce obtained by fermentation of raw materials.
 2. Seed Certifications including quantity of PLS/acre/variety.
 3. Load tickets for soil amendment verifying quantity and source, upon delivery to site and prior to spreading.
 4. Copies of delivery invoices or other proof of quantities of mulch and soil amendment.
 5. Sod shall be accompanied by certificate from vendor certifying it meets requirements of these Specifications, stating botanical name, percentage by weight, percentage of purity, germination, and weed seed for each grass species.
- 1.05 PROTECTION:
- A. Protect areas outside the approved limits of site disturbance from damage.
 - B. Reclaim any disturbance of vegetation or native ground outside of the limits of site disturbance.
 - C. Pay the cost of any fines incurred by Owner due to work being performed by Contractor outside the limits of site disturbance.
- 1.06 DELIVERY, STORAGE AND PROTECTION:
- A. General: Deliver in original, unopened containers. Protect materials from animals and moisture. Wet moldy, open, or broke packages will not be accepted. Nonflowing materials will be rejected.
 - B. Biosol:
 1. Furnish in standard containers with name and address of supplier.
 - C. Seed:
 1. Furnish in standard containers with name and address of supplier, test date, seed name and variety, lot number, net weight, percentages of purity, germination, crop seed percentage, inert matter percentage, weed seed percentage, and noxious weeds by species and number by pound, clearly marked for each container of seed.
 2. Keep dry during storage.
- 1.07 MAINTENANCE:
- A. Operations:
 1. Perform after planting until Initial Acceptance, and during warranty period, to include:
 - a. Erosion: Repair eroded areas deeper than 4 inches by filling with topsoil, seeding, and mulching.
 - b. Mulch: Replace wherever and whenever washed or blown away.
 - c. Reseed unsatisfactory areas or portions thereof during the next seeding period.
 - d. Watering: Keep seeded area moist.

PART 2 - PRODUCTS

2.01 TOPSOIL:

- A. As specified in Section 31 20 50 - "Site Preparation and Earthwork."
- B. Topsoil shall not contain toxic materials harmful to grass growth.
- C. Amend topsoil from on-site sources as specified under soil amendment.

2.02 SOIL AMENDMENT:

- A. Mycorrhizae product to be mixed into seed mix at seed supplier or incorporated into seed bed to a minimum depth of 8 inches. Biosol product to be broadcast on planted seed bed.
 - 1. 20 lb/ac granular Mycorrhizae and 1800 lb/ac Biosol Mix 7-2-3 from Rocky Mountain Bio Products, Denver, CO 303-696-8964
 - 2. 60 lb/ac of Mycorrhizae Inoculum AM 120 and Biosol at 1500 lb/ac from Pawnee Buttes Seed Company, Greeley, CO 970-356-7002

2.03 SEED:

- A. Seed shall be new crop delivered in original containers, unopened, bearing dealer's warranty analysis. Maximum crop and weed contents shall be 0.10% each. Seed shall be free of all noxious weeds. Minimum germination shall be 85% and minimum purity shall be 95%. If seed on the market does not meet minimum purity and germination percentage, compensation is to be made for a lesser percentage of purity or germination by furnishing additional seed to equal specified mix. Product comparison shall be made on basis of pure live seed (PLS) in pounds. Formula for determining quantity of PLS shall be:

$$\text{Pounds of Seed} \times \text{Purity} \times \text{Germination} = \text{Pounds PLS}$$

B. Seed Mix:

- 1. Provide fresh, clean, new crop seed complying with tolerance for purity and germination per Specifications:
 - a. Native Prairie Mix: After amendment, seed minimum 18 lbs (dryland) up to 30 lbs (irrigated) PLS/Acre or 3 lbs PLS/1,000 square feet.

Seed Type	Percent (%)
Blue Grama	29
Buffalograss	25
Green Needlegrass	5
Sideoats Grama	20
Western Wheatgrass	20
Sand Dropseed	1

- (1) Flower mix if required, additional per acre:
 - (a) Prairie Coneflower - 1lb/acre
 - (b) Blue Flax - 2 lb/acre
- b. Native Lawn Mix: After amendment, seed minimum 18 lbs (dryland) up to 30 lbs (irrigated) PLS/acre or 3 lbs PLS/1,000 square feet.

Seed Type	Percent (%)
Blue Grama	10
Buffalograss	90

- c. Acceptable Manufacturers:
 - (1) Pawnee Buttes Seed, Inc.
 - (2) Owner approved equal.
 - 2. Moldy seed or seed that has been damaged in storage shall not be used.
 - C. Seed Compost:
 - 1. Provide 3 yd³ Class 1 compost per 1,000 ft² of seeded area.
 - D. Seed Fertilizer:
 - 1. Fertilizer shall be Biosol or Biosol Forte.
 - 2. Apply fertilizer 30-34 pounds per 1,000 ft² of seeded area.
 - 3. Apply humate 15-17 pounds per 1,000 ft² of seeded area incorporated 12" into the soil.
- 2.04 LAWN SOD:
- A. Machine cut, strongly rooted, certified turf-grass sod, at least two (2) years old, and be relatively free of weeds or other undesirable native grasses. Provide sod capable of vigorous growth and development when planted (viable, not dormant).
 - B. Be composed principally of Kentucky bluegrass.
 - C. Moisten sod to depth at which it is to be cut when stripped during dry periods.
 - D. Provide sod in uniform thickness of 5/8-inch, plus or minus 1/4-inch, measured at time of cutting and excluding top growth and thatch. Strips shall be of supplier's standard size of uniform length and width with maximum five percent (5%) allowable deviation in either length or width. Broken or torn pads, or pads with uneven ends are not acceptable.
 - E. Sod pads shall be capable of supporting their own weight and retaining size and shape when pad is suspended vertically from a firm grasp on upper ten percent (10%) of pad.
 - F. Handle sod with care to prevent loss of native soil from roots.
 - G. Lawn Sod Compost:
 - 1. Provide 6 yd³ Class 1 compost per 1,000 ft² (minimum of 2" in depth) of new sod.
 - H. Lawn Sod Fertilizer:
 - 1. Fertilizer shall be 18-46-0 starter fertilizer.
 - 2. Provide 3 pounds per 1,000 ft² of new sod.
- 2.05 HYDROMULCH:
- A. Mulch may be replaced with Hydromulch at Owner's discretion.
 - B. Provide natural wood fiber free of weeds and grass seeds. The wood fiber mulch have the property of becoming evenly dispersed and suspended when agitated in water. Weight specifications from suppliers shall refer only to the air dry weight of the fiber.
 - C. Water shall be free from substances of matter that could inhibit growth of grass.

PART 3 - EXECUTION

3.01 GENERAL:

- A. Reclaim areas where construction work has been completed as soon as possible after completion of the Work.
- B. Remove all Contractor's equipment, debris, office, temporary fences, or lay-down areas, and all other Contractor's properties.
- C. Eliminate uneven areas and low spots. Remove debris, roots, branches, and stones more than 1-inch in diameter.
- D. Scarify subgrade soil to a depth of 12 inches where soil amendment is required.
- E. Upon completion and acceptance of the rough grading, place topsoil over all areas disturbed during construction that are above normal pool elevation, except those areas which will be covered with slope protection.
- F. Double the seeding rate if hand seeding.

3.02 TOPSOIL PREPARATION:

- A. Immediately prior to seeding, loosen to a depth of 12 inches. Remove stones, sticks, roots, debris, and other materials more than 1-inch.
- B. Bring to minimum depth required to meet lines, grades, and elevations shown on Contract Drawings, after light rolling and natural settlement. Grade areas to smooth even surface with a loose uniformly fine texture. Limit fine grading to areas to be promptly seeded.
- C. Owner will inspect seedbed before seeding.

3.03 SEEDING:

- A. Seeding shall only be performed between March 15 and June 15 unless otherwise approved.
- B. Apply seed with grass drill equipped with satisfactory feeding mechanism including fluff seed box, agitator, double disc furrow openers, depth bands, and packer wheels. Place seed at 1/4-inch depth. Operate drill parallel to slope. Drill equal quantity of seed in two directions at right angles to each other.
- C. Broadcast Biosol product over planted seedbed

3.04 SODDING:

- A. Provide sod for surface restoration at all residential yards, landscaped medians (i.e., Hoffman Way), and landscaped road edges.
- B. Place in spring or fall and do not place sod during a drought.
- C. Lay sod within 24-hours from time of stripping. Do not lay dormant sod or if ground is frozen.
- D. Sod shall be moist at the time it is placed.
- E. Lay sod strips along contour lines, by hand, commencing at the base of the area to be sodded and working upward:
 - 1. Carefully lay sod to produce tight joints. Butt ends and sides of sod strips; do not overlap.
 - 2. Stagger transverse joints of sod strips.
 - 3. Work from boards to avoid damage to subgrade or sod.
 - 4. Tamp or roll lightly to ensure contact with subgrade. Work sifted soil into minor cracks between pieces of sod, removing excess to avoid smothering adjacent grass.

- F. On slopes of three horizontal to one vertical (3H:1V) and steeper, anchor sod by wooden pegs. Pegs shall be 1/2" x 12", driven into the ground on about 2-foot centers. Top of peg after driving shall be not less than 1/2-inch but not more than one-inch above top of sod.
- G. Water sod with fine spray immediately after planting. During first week, water daily or more frequently as necessary to maintain moist soil to depth of four inches (4").

3.05 MULCHING:

- A. For drill seeded areas, uniformly apply mulch on all areas to be seeded at 4,000 pounds per acre air dry mulch within twenty-four hours after seeding. After applying mulch, immediately crimp with weighted discs or crimpers operated parallel to the contour. Set disc straight so minimum amount of soil is disturbed. Depth of cut shall be 3 to 4 inches. Apply uniformly at 1.5 tons per acre.

3.06 HYDROMULCHING:

- A. For drill seeded areas, uniformly apply Hydromulch at a rate of 2,000 pounds per acre. Apply tackifier at rate of 100 pounds per acre or at manufacturer's recommendation; whichever is greater. Upon completion of the application, soil shall not be visible through the Hydromulch.
- B. Tackifier, fertilizer, etc. will be included in the hydro-mulch.

3.07 MAINTENANCE:

- A. Germination during growing season is expected to be within 3 to 6 weeks. Spot regrading, reseeding, and mulching may be needed until Initial Acceptance to repair areas damaged by erosion, wind, fire, or other causes.
- B. Remove weeds by hand over 6 inches tall.
- C. Remove all litter and debris larger than 2 inches in size.

3.08 ACCEPTANCE:

- A. Contractor shall maintain seeded areas until Initial Acceptance criteria, which requires 80% growth.
- B. Any areas that do not comply with Final Acceptance criteria shall be reseeded one time by Contractor in accordance with the specifications herein.

END OF SECTION 32 92 00

DIVISION 33 - UTILITIES

SECTION 33 05 97 - UTILITY IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes identification devices for utilities.
- B. Related Work Specified Elsewhere:
 - 1. Section 33 11 00 – “Pressure Pipe”

1.02 REFERENCES:

- A. Applicable Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. A13.1 - Scheme for the Identification of Piping Systems.
 - 2. ASTM International (ASTM):
 - a. B869 - Specification for 21% Conductivity, Hard Drawn, Copper-Clad Steel Wire.
 - b. B170 - Specification for Oxygen-Free Electrolytic Copper.
 - c. D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
 - d. D2103 - Standard Specification for Polyethylene Film and Sheeting.

1.03 SUBMITTALS:

- A. Submit as specified in Thornton’s General and Special Conditions.
- B. Include, but not limited to, the following:
 - 1. Catalog information for all identification systems.
 - 2. Acknowledgment that products submitted meet requirements of the standards referenced.
- C. Identification register, listing all items in Part 3 to be identified, type of identification system to be used, lettering, location, and color.

PART 2 - PRODUCTS

2.01 TRACER WIRE:

- A. Materials:
 - 1. Tracer wire shall be as follows:
 - a. Tracing wire shall be No. 12 gauge coated wire.
 - 2. Tracer wire pipe tape shall be as follows:
 - a. 2-inch wide vinyl plastic electrical tape.
 - b. 7 mil in thickness.
 - 3. Wire Splice kits shall be as follows:
 - a. 3M R/Y connector
 - (1) Capable of handling three No. 12 wires.
 - b. Engineer approved equal.

2.02 TRACER WIRE ACCESS BOXES (TRACER WIRE TEST STATION):

- A. Access boxes shall consist of housing capable of secured mounting within water line manways.

1. Secured mounting shall be stainless steel eye-bolt or otherwise approved by City of Thornton's Construction Coordinator and/or Engineer.
- B. Terminal board hardware shall be:
 1. Pro-Mark Utility Supply, Inc - PM-10BP
 2. Engineer approved equal.
- C. See Contract Drawings for detail.

2.03 UNDERGROUND LOCATION AND WARNING TAPE:

- A. Design
 1. Size:
 - a. Minimum 6 inches in width.
 - b. Minimum overall thickness of 5 mils.
 - c. Detectable aluminum foil plastic backed tape.
 - d. Preprinted and permanently embedded.
 - e. Message continuous printed.
 - f. Minimum tensile strength: 3,500 psi
 - g. Color/Legend:
 - (1) For Water Line:
 - (a) Color: Blue with black letters
 - (b) Legend: "Caution Water Line Below"
 2. Impervious to all known alkalis, chemical reagents, and solvents found in soil
 3. Color coding shall be in conformance with the APWA/ULCC Color Code.
 4. Maximum imprint length of 36 inches.
 5. Acceptable Manufacturers:
 - a. Empire Custom Tape.
 - b. Magnatec.
 - c. Engineer approved equal.

2.04 UTILITY MARKER POSTS:

- A. Marker posts shall be 4-inch steel pipe with reflective bands and labels.
 1. Steel post shall have a wall thickness of 1/4 inch.
- B. Marker posts shall contain the following information painted in red and facing the item being marked:
 1. Manhole Number
 2. Distance from marker post to centerline of appurtenance
- C. Marker posts must be a minimum of 4 feet above existing grade.
- D. The top 6 inches of the marker posts shall be painted red.
- E. Marker posts shall be located five feet (5') from the centerline of appurtenance (in open space) or at the edge of the right-of-way (within roadway).
- F. See Contract Drawings for marker post detail.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Install identification devices at specified locations.
- B. All identification devices to be printed by mechanical process, hand printing is not acceptable.

3.02 TRACER WIRE:

- A. All utilities shall include the installation of a single tracer wire taped to the top of the pipe.
 - 1. Tracer wire shall be secured at no less than three locations per length of pipe and at every fitting or change in direction.
- B. The tracing wire shall be installed in a continuous run and the ends of the tracer wire shall be brought to the surface in test stations.
 - 1. Trace wire shall be routed around manholes/vaults and brought up into tracer wire access boxes located within the manhole/vault.
- C. Wire splices shall be accomplished using a mechanical connector and sealed with an epoxy type material.

3.03 WARNING TAPE:

- A. During the backfilling operation, continuously place pipe locating tape along centerline of buried pipe. Place twenty-four inches (24") above water line with the printed side up for visual identification.
 - 1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.

END OF SECTION 33 05 97

SECTION 33 08 00 – ABANDONMENT OF EXISTING PIPELINES AND STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes the following areas of Work:
 - 1. Abandonment and removal of
 - a. Water Mains
 - b. Valve Boxes
 - c. Fire Hydrants
 - d. PRV Vault
 - B. Related Work Specified Elsewhere:
 - 1. Section 31 20 50 – “Site Preparation and Earthwork.”
 - 2. Section 32 92 00 – “Seeding and Sodding.”
 - C. Abandonment of pipelines and structures shall be performed where shown on the Drawings or where designated by the Owner.
 - D. The Contractor shall furnish all materials, equipment and labor necessary to abandon the designated pipelines and structures in-place, or remove in their entirety, as specified or indicated on the drawings.

1.02 SUBMITTALS

- A. Submittals for controlled low strength material (CLSM) shall be made by the Contractor in accordance with the requirements set forth in Section 31 23 33.13 – “Trenching and Backfilling for Utilities.”
 - 1. The Contractor shall submit reports of material analysis, mix designs, and shall meet the requirements of the Colorado Department of Transportation (CDOT).
 - 2. The Contractor shall submit for approval of the Engineer the proposed method for filling the pipes, valve boxes, manholes, and other structures.
 - a. Contractor’s method shall take into consideration the removal of air from pipelines.
 - b. Contractor’s method shall consider the prevention of loss of fill material to the environment.
 - c. Contractor’s submittal shall include acceptable information on plugs, pumping equipment, proposed method for maintaining utilities to remain in service, and any required equipment or personnel certifications.

PART 2 - PRODUCTS

2.01 CLSM:

- A. Specified in Section 31 23 33.13 – “Trenching and Backfilling for Utilities.”

2.02 SEED AND SOD

- A. Specified in Section 32 92 00 – “Seeding and Sodding.”

PART 3 - EXECUTION

3.01 PIPE ABANDONMENT

- A. Unless designated for removal, the Contractor shall abandon all pipes and structures indicated on the drawings.
 - 1. Existing Pipelines (Larger than 2-inch Diameter)
 - a. Existing pipes indicated on the Drawings to be abandoned shall be plugged at the required locations and abandoned as follows:
 - (1) Pipes shall be closed with an approved plug or cap with required restraint as approved by the Engineer.
 - (a) Plug or cap as required to keep the system in service until the time that the line can be abandoned with as little inconvenience to customers as possible. See Section 01 11 00 Summary of Work .
 - 2. Existing Pipelines Two (2) Inches and Smaller in Diameter
 - a. Unless specifically called for on the Drawings to be removed, pipelines two (2) inches and smaller in diameter shall be abandoned in place.
 - b. Shall not be required to be filled with CLSM.
 - c. Shall have their ends crimped or plugged, as approved by the Resident Field Engineer.

3.02 VALVE AND VALVE BOX REMOVAL

- A. Before removal and abandonment of valve box, the valve shall be fully opened, as to help accommodate abandonment of the main line with CLSM fill.
- B. At a minimum, remove and dispose of the top two (2) feet of all existing valve boxes designated to be abandoned, including the valve box structure and cover.
 - 1. The top of the valve box shall be unscrewed, broken out, or by other method removed and disposed of by the Contractor.
- C. All existing valve box void space of the structure shall then be filled with CLSM fill.
 - 1. Include the void space in and around the existing valve operation nut.
 - 2. Include the void space in the existing valve box structure.
 - 3. Include the void space left after removing the valve box.
- D. Provide asphaltic patches at all removed valve boxes in the road.
 - 1. Provide in accordance with SECTION 32 12 15.
 - 2. Asphalt shall be installed as to leave no evidence that a valve box once existed at the location.
 - 3. Saw cut asphalt as to provide full depth removal and replacement.
 - 4. Provide patch at 2-foot by 2-foot minimum square as to adequately compact.
 - 5. Match existing asphalt thickness plus one (1) inch.
- E. Provide surface restoration at all removed valve boxes in the outside of the road.
 - 1. Remove and dispose of concrete collar (as required).
 - 2. Remove and dispose of marker post (as required).
 - 3. Provide top soil, seed, and/or sod as required to match and restore ground surface.

3.03 FIRE HYDRANT REMOVAL

- A. Fire hydrants (tops) shall be removed and salvaged in their entirety.
 - 1. The Contractor will be responsible for delivery and will coordinate delivery to the Owner's materials yard.

- B. Hand excavate around the hydrant barrel to provide the least disturbance to property around the hydrant.
- C. Preserve rock, gravel, stones, mulch, sod, and other landscaping materials surrounding hydrant barrel.
 - 1. Reinstall landscaping surface after removal of the hydrant barrel and installation of top soil.
- D. Saw cut the hydrant barrel at least 12-inches below the bottom hydrant flange.
- E. Provide top soil, seed, and/or sod as required to match and restore ground surface.

3.04 EXISTING PRV REMOVAL (SITE 3)

- A. Remove and salvage or dispose of pressure-reducing valve at Owner or Engineer's direction.
- B. Completely fill interior of vault with CLSM.
- C. Remove and abandon existing vent piping to facilitate construction.

END OF SECTION 33 08 00

SECTION 33 11 00 – PRESSURE PIPE

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes all pressure pipe, fittings, specials, and appurtenances.
- B. Related Work Specified Elsewhere:
 - 1. Section 09 90 00 – “Painting and Coating.”
 - 2. Section 33 12 16 – “Utility Valves and Accessories.”
 - 3. Section 33 31 50 – “Pipe Installation.”

1.02 REFERENCE STANDARDS:

- A. Applicable Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO).
 - 2. American Water Works Association (AWWA):
 - a. A307 - Standard Specification for Carbons Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
 - b. C110 - Ductile-Iron and Gray-Iron Fittings.
 - c. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - d. C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - e. C150 - Thickness Design of Ductile-Iron Pipe.
 - f. C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
 - g. C153 - Ductile-Iron Compact Fittings.
 - h. C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.
 - i. C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings.
 - j. M23 - PVC Pipe-Design and Installation.
 - k. M41 - Ductile-Iron Pipe Fittings.
 - 3. ASTM International (ASTM):
 - a. A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - b. A536 - Standard Specification for Ductile Iron Castings.
 - c. D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
 - d. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
 - e. F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - 4. National Sanitation Foundation (NSF):
 - a. NSF 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS:

- A. Submit as specified in Thornton’s General and Special Conditions
- B. Submit the following for acceptance prior to fabrication:
 - 1. Pipe and joint details.
 - 2. Special, fitting, and coupling details.
 - 3. Laying and installation schedule.

- 4. Specifications, data sheets, and affidavits of compliance for protective shop coatings and linings.
- 5. Manufacturer's design calculations including, but not limited to, wall thickness and deflection under specified live and dead loads.
- C. Certificates and Affidavits: Furnish the Following Prior to Shipment:
 - 1. Affidavit of compliance with applicable standard.
 - 2. Certificate of origin for all steel flanges. Flanges shall be manufactured in the U.S.A.
 - 3. Test certificates.

1.04 QUALITY ASSURANCE:

- A. Manufacturers shall be experienced in the design and manufacture of pipe, fittings, specials, or appurtenances for a minimum period of 5 years.

1.05 DELIVERY, STORAGE AND HANDLING:

- A. Specific in Section 33 31 50 – “Pipe Installation”

PART 2 - PRODUCTS

2.01 PIPE REQUIREMENTS:

- A. Furnish pipe of materials, joint types, and sizes as indicated or specified.
- B. Pipe shall be designed to withstand all stresses resulting from external loads and internal pressures listed in the following table plus applicable allowance for surge unless otherwise specified:

Location	Nominal Pipe Size (in)	Live Load	Design Internal Working Pressure	Design Maximum Test Pressure
Site 1	6	HS-20	100	150
Site 2	6	HS-20	100	150
Site 3	12	HS-20	100	150
Site 4	6	HS-20	100	150
Site 5	8	HS-20	100	150
Site 6	8	HS-20	100	150
Site 7	12	HS-20	100	150
Site 8	6	HS-20	100	150

- C. Pipe Marking: All pipe and fittings shall be marked conforming to the applicable standard specification under which the pipe is manufactured and as otherwise specified.

2.02 DUCTILE IRON PIPE:

- A. Design and Manufacture of Pipe:
 - 1. Ductile iron pipe shall conform to AWWA C115, C150, and C151 except as otherwise specified.

2. With laying condition Type 5 for ductile iron for load requirements tabulated herein.
 - a. Use E' of 700 and bedding angle of 90°.
 - b. 3% deflection limit.
 - c. Add service allowance and standard casting tolerances of AWWA C150 and AWWA C151.
 - d. Select standard pressure class thickness next above total calculated thickness.
 - B. Joints:
 1. Flanged:
 - a. Provide flanged joints for all interior pipe.
 - b. Flanges for pipe shall be ductile iron and conform to the applicable provisions of AWWA C110 and C115 and shall be drilled ANSI B16.1 Class 125.
 2. Restrained:
 - a. Furnish for all fittings and where joint restraint is required to offset internal pipeline forces.
 - C. Lining:
 1. All pipe and fittings shall be cement-mortar lined in accordance with AWWA C104.
 - D. Coating:
 1. All iron pipe and fittings shall be coated with manufacturer's standard bituminous paint coating.
 2. Flange faces shall be coated in accordance with AWWA C115.
- 2.03 PVC PIPE:
- A. Materials:
 1. Materials shall conform to AWWA C900.
 2. Gaskets shall conform to ASTM F477 and be synthetic rubber.
 - B. Design of Pipe: Design shall conform to AWWA C900 and as specified:
 1. Internal Loading:
 - a. Internal pressure specified plus allowance for surge pressure conforming to AWWA C900.
 - b. Hydrostatic test pressure as specified.
 2. External Loading:
 - a. Earth dead load cover at 120 pounds per cubic foot (pcf) plus AASHTO H-20 live loads.
 - b. 5% deflection limit.
 - c. Bedding condition as indicated.
 3. Use E' of 700 and bedding angle of 90°.
 - C. Dimensions: The minimum pressure class for PVC pipe shall be as follows:

Location	Nominal Pipe Size (in)	Dimension Ratio (DR)	Minimum Pressure Class (psi)
Site 1	6	18	235
Site 2	6	18	235
Site 3	12	18	235
Site 4	6	18	235
Site 5	8	18	235
Site 6	8	18	235
Site 7	12	18	235
Site 8	6	18	235

- D. Diameters: PVC pressure pipe shall have Cast-Iron-Pipe-Equivalent (CI) outside diameters.
- E. Joints: Pipe shall be furnished with integral bell-type pipe ends designed for joint assembly using elastomeric gaskets.
- F. Fittings:
 - 1. Fittings shall conform to AWWA C110 or C153 and be ductile iron. Fittings shall be mechanical joint or push-on type joint.
 - 2. All ductile iron fittings shall be fusion bonded epoxy coated and lined per AWWA C116.
 - 3. Fittings shall have a pressure rating of not less than that specified for the pipe.
 - 4. Fittings for pipe with push on joints shall be mechanical joint or push-on type joint.
 - 5. Include all specials, taps, plugs, flanges and wall fittings as required.
 - 6. Provide openings for combination air valve, testing and other connections via saddle connection located where indicated.
- G. Marking: Identification markings on pipe shall conform to AWWA C900.
- H. Color:
 - 1. The color for PVC pressure pipe shall indicate the contents within the pipe and shall be as follows:

Location	Contents	Pipe Color
Waterline	Potable Water	Blue

2.04 RESTRAINING SYSTEMS:

- A. All bolting hardware shall be type 304 stainless steel.
- B. Harness Rods:
 - 1. Harness rods and nuts shall be type 304 stainless steel.
- C. Joint Restraint Devices:
 - 1. Shall be manufactured of ductile iron conforming to ASTM A536.
 - 2. Shall have twist-off nuts, sized the same as the tee head bolts used to ensure proper torque.
 - 3. Mechanical Joint Restraining Devices:
 - a. Minimum working pressure equal to that of pipe for PVC.

- b. Shall be supplied with a premium tight bonded epoxy coating system (StarBond or Engineer approved equal).
 - c. Acceptable Manufacturers:
 - (1) EBAA Iron - Series 2000
 - (2) Star Pipe Products - Series 4000
 - (3) Engineer approved equal.
 - d. Design:
 - (1) Provide with premium tight-bonded epoxy costing (Mega-Bond, Star-Bond, or Engineer approved equal).
 - 4. Push-on joint bell restraint harnesses
 - a. Minimum working pressure equal to that of pipe for PVC
 - b. Acceptable Manufacturers:
 - (1) EBAA Iron - Series 1500, Series 1600, Series 2800
 - (2) Smith-Blair, Series 165
 - (3) Engineer approved equal.
 - c. Design:
 - (1) Provide with premium tight-bonded epoxy coating (Mega-Bond, Star-Bond, or Engineer approved equal).
 - D. Proprietary Manufacturer Systems:
 - 1. All proprietary manufacturer systems for restrain joint pipe shall meet the manufacturer's installation, testing, QA/QC requirements.
 - 2. The following systems are acceptable:
 - a. Fusible-PVC
 - b. Integral Joint Restraints:
 - (1) Eagle Loc 900™
 - (2) Engineer Approved Equal.
 - E. Thrust Blocks
 - 1. Concrete Thrust blocks to be installed where indicated on the Contract Drawings
 - 2. Refer to Thrust Block detail in the Contract Drawing as well as City of Thornton Standards and Specifications (Rev October 2012) Section 600.
- 2.05 SLEEVES AND COUPLINGS:
- A. Sleeves:
 - 1. AWWA C110 mechanical joint ductile iron solid sleeve type:
 - a. Pipe end space shall not exceed one-third of the sleeve laying length.
 - b. Interior, exposed, exterior, or buried service as indicated.
 - B. Couplings:
 - 1. Center sleeve and compression gland-type end ring conforming to AWWA C219.
 - 2. Center sleeve shall be without pipe stop.
 - 3. Couplings for exposed interior iron or PVC pipe may be steel or iron.
 - 4. Fastener bolts shall be stainless steel for ductile iron couplings. Bolts for direct buried coupling installations shall be stainless steel.
 - 5. Center sleeve and end rings shall be:
 - a. Ductile iron for iron couplings.
 - 6. Lining and Exterior Coating:
 - a. Completely coat center sleeve and end rings.
 - b. Two-part epoxy or nylon fuse-coated to a minimum 10 mils thickness.

- c. Line interior of all steel couplings intended for exposed-interior installations. Coat exterior with normal shop coating.
- C. Flanged Coupling Adapters:
 - 1. Flanged end and body to be one unit conforming to AWWA C219. Coupling end to be compression gland type with follower ring.
 - 2. Adapters for joining direct buried, exposed exterior, vault or pit installations of iron pipe shall be iron.
 - 3. Adapters for joining exposed interior iron pipe may be steel or iron.
 - 4. Flanged end bolt circle, bolt size, and spacing shall conform to the applicable provisions of ANSI B16.1 and shall be drilled Class 125 for iron adapters. Flanges on steel adapters shall be AWWA C207, Class D, drilled ANSI B16.1 Class 125.
 - 5. Bolts and nuts shall be ductile iron for iron adapters and high-strength, low-alloy steel for steel adapters.
 - 6. Anchor studs shall not be used where joint restraint is required. Furnish adapters with tie rod harness assemblies where indicated.
 - 7. Mechanical joint retainer glands shall not be used where joint restraint is required unless indicated. When indicated, retainer glands shall be Megalug manufactured by EBAA Iron, Inc. or Engineer approved equal.
- D. Dismantling Joint:
 - 1. Consists of a mechanical joint fitting located between two pipe flanges with restraining rods across the mechanical joint section, providing a restrained system with integral space for removal of adjacent equipment.
 - 2. Shall conform to AWWA C219.
 - 3. Materials shall be steel.

2.06 GASKETS AND BOLTING MATERIALS:

- A. Provide all gaskets, bolts, lubricant, and other accessories required to install pipe, fittings, and specials complete and ready for service.
- B. Gaskets for push-on pipe shall be flexible elastomeric gaskets meeting the requirements of ASTM F477 and shall be synthetic rubber.
- C. Gaskets for fittings 12-inch and smaller shall have "nominal" inside diameters, not the larger inside diameters per ANSI B16.21.
 - 1. Gaskets for ductile iron flanged pipe shall conform to ASTM D1330, Grade 1, red rubber, ring type, or U.S. Pipe "Flange-Type", 1/8-inch thick.
- D. Bolts for flanged joints shall conform to ASTM A307, Grade B. Nut and bolt heads shall be hexagonal.

PART 3 - EXECUTION

3.01 FIELD PROTECTIVE COATING:

- A. Specified in SECTION 09 90 00 - PAINTING AND COATING.

3.02 INSTALLATION:

- A. Specified in SECTION 33 31 50 - PIPE INSTALLATION.

3.03 FIELD TESTING:

- A. Specified in SECTION 33 31 50 - PIPE INSTALLATION.

END OF SECTION 33 11 00

SECTION 33 12 16 - UTILITY VALVES AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes all valves and accessories.
- B. Related Work Specified Elsewhere:
 - 1. Section 09 90 00 - "Protective Coatings."
 - 2. Section 33 31 50 - "Pipe Installation."

1.02 REFERENCES:

- A. Applicable Standards:
 - 1. This section must comply with City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012.
 - 2. American National Standards Institute (ANSI):
 - a. B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
 - 3. ASTM International (ASTM):
 - a. A126 - Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - b. A276 - Stainless and Heat Resisting Steel Bars and Shapes.
 - c. A536 - Ductile Iron Castings.
 - d. A564 - Hot Rolled and Cold Finished Age Hardening Stainless and Heat Resisting Steel Bars and Shapes.
 - 4. American Water Works Association (AWWA):
 - a. C111 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
 - b. C502 – Dry-Barrel Fire Hydrants.
 - c. C504 - Rubber-Seated Butterfly Valves.
 - d. C508 Swing Check Valves for Waterworks Service, 2 Inch through 24 Inch NPS.
 - e. C512 - Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
 - f. C550 - Protective Epoxy Interior Coatings for Valves and Hydrants.
 - g. C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

1.03 SUBMITTALS:

- A. Submit as specified in Thornton's General and Special Conditions.
- B. Include, but not limited to, the following:
 - 1. Catalog data or illustrations showing principal dimensions, parts, and materials.
 - 2. Spare parts list referenced to illustration of parts.
 - 3. Assembly and disassembly or repair instructions.
 - 4. Valve coating information including performance tests of adhesion, hardness, and abrasion resistance.
 - 5. Material description of gaskets, seals, and seats.
- C. Operation and Maintenance Manual in accordance with Section 01 33 00 - "Submittals."
- D. Certificates and Affidavits: Furnish prior to shipment. Include the following:

1. Test certificates.
2. Affidavit of compliance with applicable AWWA Standard.

1.04 QUALITY ASSURANCE (QA):

- A. Manufacturers shall be experienced in the design and manufacture of specific valves and accessories for a minimum period of 5 years.
- B. Manufacturers shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.

1.05 DELIVERY, STORAGE, AND HANDLING:

- A. Ship all valves with suitable end covers to prevent entrance of foreign material into valve body.
- B. Protect valve threads, flanges, stems, and operators from damage.
- C. Ship valves 2-1/2-inch and larger to the Project Site tagged with the valve number shown on the Contract Drawings. Tag smaller valves to show the piping system in which it is to be used.

1.06 RESPONSIBILITY:

- A. Actuators, their controls, and accessories shall be the responsibility of the valve manufacturer for sizing, assembly, certification, field testing, and any adjustments necessary to operate the valve as specified.

PART 2 - PRODUCTS

2.01 RESILIENT-SEATED GATE VALVES:

- A. Acceptable Manufacturers:
 1. American Flow Control, series 2500
 2. Mueller, series 2360
 3. American AVK, Series 45
- B. Design:
 1. Conform to AWWA C509 or C515 and as specified.
 2. Non-rising brass stem.
 - a. All stem seals shall be double O-ring type.
- C. Actuators:
 1. All valves shall open counterclockwise (left).
 2. All valves shall have a 2-inch-square operating nut.
- D. Interior and Exterior Coating:
 3. Conform to AWWA C550.
 4. Apply to all interior and exterior ferrous metal surfaces.
 5. The coating shall be a two-part thermosetting epoxy suitable for field over coating and touch-up
 - a. Minimum thickness of four mils.
- E. Testing:
 6. Testing shall be performed conforming to AWWA C509.
 7. Furnish affidavit of compliance.
- F. Valve Schedule:
 8. See drawings for sizes and locations.

2.02 VALVE BOXES:

- A. Shall conform to City of Thornton's *Standards and Specifications for the Design and Construction of Public and Private Improvements*, October 2012, and Standard Drawings No. 200-6B.
- B. Acceptable Manufacturers:
 - 1. Tyler Company, Series 6860.
 - 2. Engineer approved equal.
- C. Provide for all buried valves and at vaults with drilled hole for operator access.
- D. Design:
 - 1. Conforming to ASTM A48, Class 20A.
 - 2. Gray cast iron, buffalo type.
 - 3. Boxes shall be three-piece cast iron screw type with 5-1/4-inch shaft.
 - a. Shall be adjustable from 45 to 66 inches.
 - 4. Use wide oval base #160.
 - 5. Provide extension stem to bring operating nut within 2 feet of valve box top.
- E. Cover (Lids):
 - 1. Drop cover shall be marked "WATER."
 - 2. Lids shall have a lip or flange extending into the valve box shaft.
 - a. No slip type boxes will be allowed.

2.03 COMPRESSION COUPLINGS:

- A. Acceptable only for sizes between ¾-inch to 2-inch
 - 1. Acceptable Manufacturers:
 - a. McDonald – 4758Q
 - b. Ford – C44-G
 - c. Mueller – H-15403

2.04 BLOW OFF ASSEMBLIES:

- A. Acceptable Manufacturers
 - 1. Kupferle Foundry, Model TF500

2.05 FIRE HYDRANTS

- A. See Contract Drawings.

2.06 SHOP PAINTING:

- A. Prepare surfaces and paint or coat all valves, floor stands, valve boxes, and all related accessories standard of the manufacturer unless otherwise specified herein.
- B. Paint and coatings shall be suitable for the service intended.
- C. Submit type of paint or coating proposed with drawings and data for Engineer approval prior to fabrication.

PART 3 - EXECUTION

3.01 INSTALLATION:

- A. Comply with provisions of AWWA C600, C605 and as specified.
- B. Thoroughly clean and remove all shipping materials prior to setting. Operate all valves from fully opened to totally closed.
- C. Equip with anchorage where indicated.

3.02 FIELD PAINTING: Surface preparation and finish painting are specified in Section 09 90 00 - "Protective Coatings."

3.03 FIELD TESTING:

- A. Perform on piping and valves as specified in Section 33 31 50 - "Pipe Installation" and for the following:
 - 1. Gate valves.
 - 2. Blowoff Valves

END OF SECTION 33 12 16

SECTION 33 31 50 - PIPE INSTALLATION

PART 1 - GENERAL

1.01 SUMMARY:

- A. This Section includes handling, installation and testing of pipe, fittings, specials, and appurtenances as indicated or specified.
- B. Related Work Specified Elsewhere:
 - 1. Section 09 90 00 - "Protective Coatings."
 - 2. Section 33 11 00 - "Pressure Pipe"
 - 3. Section 33 12 16 - "Utility Valves and Accessories."

1.02 REFERENCES:

- A. Applicable Standards:
 - 1. American Water Works Association (AWWA):
 - a. C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - b. C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - c. C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
 - d. C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
 - e. M23 - PVC Pipe - Design and Installation.
 - f. M55 - Manual for the Design and Installation of Polyethylene Pipe in Water Applications.
 - 2. Federal Specifications (FS):
 - a. SS-S-00210 - Sealing Compound, Preformed Plastic, For Expansion Joints and Pipe Joints.

1.03 DELIVERY, STORAGE AND HANDLING:

- A. Handle in a manner to ensure installation in sound and undamaged condition.
 - 1. Do not drop or bump.
 - 2. Use slings, lifting lugs, hooks, and other devices designed to protect pipe, joint elements, linings, and coatings.
- B. Ship, move, and store with provisions to prevent movement or shock contact with adjacent units.
- C. Handle with equipment capable of work with adequate factor of safety against overturning or other unsafe procedures.

PART 2 - PRODUCTS: SPECIFIED IN RESPECTIVE SECTIONS, THIS DIVISION.

PART 3 - EXECUTION

3.01 DELIVERY AND OFF-LOADING:

- A. Each pipe shipment should be inspected prior to unloading to see if the load has shifted or otherwise been damaged. Notify Engineer immediately if more than immaterial damage is found. Each pipe shipment should be checked for quantity and proper pipe size, pressure class, color, and type.
- B. Pipe should be off-loaded and otherwise handled in accordance with AWWA M23, C151, M55 and all of the pipe manufacturer's guidelines shall be followed.

- C. Off-loading devices such as chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited.
- D. During removal and handling, be sure that the pipe does not strike anything. Significant impact could cause damage, particularly during cold weather.
- E. If appropriate unloading equipment is not available, pipe may be unloaded by removing individual pieces. Care should be taken to insure that pipe is not dropped or damaged.
- F. Pipe shall not be dumped, dropped, pushed, etc., from the truck. Pipe should be carefully lowered from trucks. Pipe must be offloaded in a manner to prevent damage to the pipe.
- G. Ship all material to the Site and store in assigned laydown areas or as directed by Owner.
- H. Stored pipe shall not be stacked greater than the pipe manufacturer's recommendations.
 - 1. Pipe shall not be stacked greater than two pipes high.

3.02 HANDLING AND STORAGE:

- A. Handling and storage shall be in accordance with manufacturer's requirements.
- B. Any scratch or gouge greater than 7% of the wall thickness will be considered significant and can be rejected unless determined acceptable by the Contractor.
- C. Any length of pipe showing a crack or which has received a blow that may have caused a defect, even though no such defect can be seen, shall be marked as rejected and removed at once from the Work. Damaged areas, or possible areas of damage may be removed by cutting out and removing the suspected incident fracture area. Limits of the acceptable length of pipe shall be determined by the Contractor.
- D. Pipe lengths should be stored and placed on level ground. Pipe should be stored at the Site in the unit packaging provided by the manufacturer. Caution should be exercised to avoid compression, damage, or deformation to the ends of the pipe. Pipe shall be stored so as to not exceed the recommended stacking height provided by the manufacturer. The interior of the pipe, as well as all end surfaces, should be kept free from dirt and foreign matter.
- E. Pipe shall be handled and supported with the use of woven fiber pipe slings or approved equal. Care shall be exercised when handling the pipe to not cut, gouge, scratch, or otherwise abrade the piping in any way.
- F. Stored pipe be shaded or otherwise shielded from direct sunlight. Covering of the pipe which allows for temperature build-up is strictly prohibited. Pipe should be covered with an opaque material while permitting adequate air circulation above and around the pipe as required to prevent excess heat accumulation.
- G. Pipe shall only be stored and stacked per the pipe manufacturer's guidelines.

3.03 INSTALLATION - GENERAL:

- A. Use equipment, methods, and materials ensuring installation to lines and grades indicated.
 - 1. Maintain within tolerances specified or acceptable laying schedule.
 - a. Alignment: approximately 1 inch per 100 feet in open cut or trenchless.
 - b. Grade: approximately 1 inch per 100 feet of design centerline elevation such that:

- (1) Under no circumstance may grade tolerance interrupt designed (positive or negative) grade.
 - (2) Waterlines approaching air release valves from low point shall maintain positive grade.
 - (3) Waterlines leaving air release valves shall maintain negative grade to low point.
2. Do not lay on blocks unless pipe is to receive total concrete encasement.
 3. Accomplish horizontal and vertical curve alignments with bends, bevels, and joint deflections.
 4. Obtain acceptance of method proposed for transfer of line and grade from control to the Work.
- B. Install pipe of size, materials, strength class, and joint type with embedment indicated for plan location.
- C. Clean interior of all pipe, fittings, and joints prior to installation. Exclude entrance of foreign matter during installation and at discontinuance of installation.
1. Close open ends of pipe with snug-fitting closures.
 2. Do not let water fill trench. Include provisions to prevent flotation should water control measures prove inadequate.
 3. Remove water, sand, mud, and other undesirable materials from trench before removal of end cap.
- D. Brace or anchor as required to prevent displacement after establishing final position.
- E. Perform only when weather and trench conditions are suitable. Do not lay in water.
- F. Observe extra precaution when hazardous atmospheres might be encountered. All field joints shall be inspected, tested, and recorded prior to backfilling.

3.04 JOINTING:

- A. General Requirements:
1. Locate joint to provide for differential movement at changes in type of pipe embedment, impervious trench checks, and structures.
 - a. Not more than twenty-four inches (24") from structure wall, or
 - b. Support pipe from wall to first joint with concrete cradle structurally continuous with base slab or footing.
 - c. As indicated.
 2. Perform conforming to manufacturer's recommendations.
 3. Clean and lubricate all joint and gasket surfaces with lubricant recommended.
 4. Use methods and equipment capable of fully seating or making up joints without damage.
 5. Check joint opening and deflection for specification limits.
- B. Special Provisions for Jointing PVC Pipe:
1. Conform to AWWA C605 and AWWA M23.
 2. Excavate bell holes at each joint or coupling to provide full length barrel support of the pipe and to prevent point loading at the bells or couplings.

3.05 CUTTING:

- A. Cut in neat manner without damage to pipe.

- B. Observe Specifications regarding joint locations.
- C. Cut PVC with carborundum saw or other acceptable method per manufacturer's instructions.
 - 1. Smooth cut by power grinding to remove burrs and sharp edges.
 - 2. Repair lining as required and approved.

3.06 CLOSURE PIECES:

- A. Connect two segments of pipeline or a pipeline segment and existing structure with short sections of pipe fabricated for the purpose.
- B. Observe Specifications regarding location of joints, type of joints, and pipe materials and strength classifications.
- C. Field-fabricated closures, where required, shall be concrete encased between adjacent flexible joints.
- D. May be accomplished with sleeve coupling:
 - 1. Of length such that gaskets are not less than 3 inches from pipe ends.
 - 2. Wrap exterior of buried steel couplings with polyethylene encasement conforming to AWWA C105.

3.07 FIELD PAINTING:

- A. Specified in Section 09 90 00 – “Protective Coatings.”

END OF SECTION 33 31 50