

ALTERNATE #3 – Concourse A Sewer Repairs

RE: Existing Sewer Inlet Pipes in Basement of Concourse A

Alternate #3.1 – Pipe Survey

Add Technical Specification Section 220130.16 –Television Inspection of Sewer Pipelines

Drawing Reference M101A to M104 – Add General Note 4:

- A. High pressure jet wash all existing lines as shown on Reference Drawings M700A to M708A (marked drawings to be provided successful bidder). Estimate 6430LF.
- B. Scope/Camera/Record (see TSS 220130.16). Field verify and inspect all existing lines as noted above. Report all conditions (sizes, laterals, etc.) and locations of any breaks, blockages, or other signs of deterioration/corrosion (include connection points, like clean-outs, manholes etc. for follow up lining work, if possible). Submit to DEN Project Manager.
- C. Provide LF Unit price for entire scope of work – i.e., cleaning, scoping, and reporting (as defined above).

Alternate #3.2 – Pipe Repairs

Add Technical Specification Sections: 033053 – Miscellaneous Cast-In-Place concrete (Limited Applications); 220131- Sewer Pipe Point Repair and Obstruction Removals; 312319 – Dewatering; 312333 – Trenching and Backfilling

Provide price for the following:

- A. Remove and Replace any inlet pipe (with PVC as per TSS 221316 & 220131) that is reported broken or blocked as per inspection in Alternate #3.1, upon direction from DEN PM. Include entire assembly (i.e., excavation, backfill, compaction, repaving, restriping, if needed, etc.). Provide bulk quantity discount prices, in four foot lengths, as appropriate:

Quantity 1-5 (4' lengths)	\$____/LF
Quantity 6-10 (4' lengths)	\$____/LF
Quantity 11-15 (4' lengths)	\$____/LF
Quantity 16-20 (4' lengths)	\$____/LF

Alternate #3.3 – Pipe Lining

Provide unit cost for the following:

- A. Review previous pipe lining specification (to be provided if proceeding), modify as necessary, and provide proposal to DEN for review and acceptance.
- B. Line inlet pipes from sump to next connection point (clean-out, manhole, lateral etc.). Condition and Length to be identified by Pipe Survey (Alt. 3.1). Work to include cleaning, lining, scoping etc. Must include determination if lining will effect pipe capacity.

SECTION 220130.16 - TELEVISION INSPECTION OF SEWER PIPELINES

PART 1 GENERAL

1.1 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. National Association of Sewer Service Companies (NASSCO): Pipeline Assessment Certification Program (PACP).
 2. Occupational Safety and Health Act (OSHA).

1.2 SUBMITTALS

A. Action Submittals:

1. Catalog and manufacturer's data sheets for television equipment.
2. Acceptance Standard closed-circuit television (CCTV) video; two copies.

B. Informational Submittals:

1. Certification that staff to be used for the Work is properly trained in confined space entry and hazardous atmospheres.
2. Training and inspection plan, seven (7) days prior to manual inspection.
3. Confined space entry procedures.
4. CCTV Inspection:
 - a. Include the following with each inspection submitted:
 - 1) Inspection media.
 - 2) Inspection reports.
5. Log of cable footage counter calibration checks.
6. Listing of actual measured flow depth and times.
7. Project-specific Safety Plan.
8. Confined space entry permits as needed, if area is determined to be confined space. If not, still use safe practices (i.e., use air monitor, ventilate, and have constant supervision/watcher). (Permit to be provided to DEN).

1.3 QUALITY ASSURANCE

- A. Prestart up Meeting: Contractor to coordinate with DEN Project Manger and Airport Ops when completing CCTV in operational locations.
- B. Acceptance Standard CCTV Video:
 - 1. DVD format showing example quality of work that Contractor proposes for Project.
 - 2. Submittal shall also include examples that demonstrate camera advancement speeds, picture clarity, environment condition, lighting, panning as well as focus on defects, title frame, and screen labels for images, and sample stills.
 - 3. Picture quality and definition shall be to satisfaction of DEN Project Manager.

1.4 SEQUENCE AND SCHEDULING

- A. Contractor shall coordinate scheduling with DEN Project Manager and Airport Ops prior to inspections.
- B. Contractor shall complete CCTV prior to all cleaning, coating and corrosion protection, excavation and/or rehabilitation for point pipeline repairs.
- C. Contractor shall complete CCTV after all cleaning, coating and corrosion protection, excavation and/or rehabilitation for point pipeline repairs.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 GENERAL

- A. Complete closed-circuit television (CCTV) inspection for pipe segments as indicated on Drawings prior and post to any cleaning, excavation and/or rehabilitation work.
 - 1. Label assets and structures in inspection records using same identification nomenclature in a System Rehabilitation Mapbook on drawings.
- B. Complete applicable Work specified in Section 225728, Temporary Flow Control prior to starting CCTV inspection work.
- C. Record entry positions and scope directions on drawings for submittal for as-builts. Records must also correlate to video submittals. Identify each inlet pipe to sump basin with unique label to sump basin on as-built drawings correlated to video scope. Start numbering with the northern most pipe inlet, continue consecutive counting from first inlet noted with direction in a clockwise manner.
- D. Measure and record flow depths and times of measurement at a sufficient number of locations to indicate flow depths that could be expected during inspection work. A minimum of one (1) flow depth measurement shall be recorded for each line section.

3.2 NOTIFICATIONS

A. DEN Project Manager:

1. A minimum of five (5) days prior to the anticipated commencement of inspections landside.
2. When obstruction, restricting flow in pipeline, is discovered.
3. If depth of flow in pipeline exceeds 25 percent of pipe diameter.
4. If conditions for CCTV inspection are found to be unsafe or impractical.
5. Pipe configuration in field is different than shown on maps; include diagram clearly indicating location of structure in relation to immediately adjacent structures.

3.3 EQUIPMENT

A. Inspection Vehicle:

1. Equipped with monitoring equipment specifically compatible with sewer inspection equipment and meet DEN Security requirements.
2. Equipped with a safety backup alarm and traffic warning flashers.
3. Clearly marked with the inspection company name and phone number.

B. Inspection Equipment:

1. Inspection equipment that fails to produce satisfactory inspection quality shall be removed from the Work.
2. Transport Platform:
 - a. Self-propelled, mounted on skid, or mounted on float.
 - b. Sized for each pipe diameter in accordance with manufacturer's recommendations.
 - c. Cables: 1,000 feet long, minimum.
 - d. Equipped with tag line suitable for pulling camera backwards.
 - e. Equipped with winch, power winch, TV cable, powered rewind, or other devices used to move camera through pipe.
 - 1) When powered and controlled winches are used to pull television camera through line, provide telephones, radios, or other means of communication between the two (2) cleanouts to ensure communications exist between crewmembers.
 - f. Remote Reading Footage Counter:
 - 1) Accuracy: 0.20 foot over length of section being inspected.
 - 2) Counter display.

SECTION 220130.16 - TELEVISION INSPECTION OF SEWER PIPELINES

- 3) Marking on cable will not be allowed.
- 4) Calibration: Perform each day prior to setup.
- g. Secure cable, chains, and other devices used with camera so as not to obstruct camera view or otherwise interfere with proper documentation of sewer conditions.

- 3. Television Camera:
 - a. Closed-circuit color television camera.
 - b. Sufficient for 3–inch through 12–inch diameters and in accordance with manufacturer’s recommendations.
 - c. Mounted on transport platform.
 - d. Operative in 100 percent humidity conditions without lens fogging.
 - e. Operative in hazardous and corrosive environment and specifically designed for pipeline inspection.
 - f. Camera Lighting:
 - 1) Mounted on and turned in direction of camera head.
 - 2) Light Sensitivity: Greater than 1.5 lux minimum.
 - 3) Minimize reflective glare.
 - 4) Remote variable intensity control.
 - 5) Provide clear, in-focus picture of entire inside periphery of pipe.
 - 6) Ability to achieve proper balance of tint and brightness.
 - g. Resolution:
 - 1) Horizontal Resolution: 460 lines minimum.
 - 2) Vertical Resolution: 400 lines minimum.
 - 3) Meet or exceed monitor resolution.
 - h. Rotation: 360 degrees.
 - i. Pan and Tilt: 270 degrees, with adjustable supports designed for operation in connection with pipe inspection.
 - j. Viewing Angle: 65 degrees, minimum.
 - k. Focus and Iris Controls:
 - 1) Automatic or remote.
 - 2) Remote control adjustment for focus and iris.
 - l. Focal Distance: Adjustable through range from 6 inches to infinity.
 - m. Zoom: Capable of 40:1 (10x optical, 4 times digital).

3.4 INSPECTION

- A. Video Recording:
 - 1. CCTV inspection is represented by one cleanout-to-cleanout pipe segment or other access-to-access point; not multiple cleanout-to-cleanout segments.
 - 2. Prior to beginning CCTV inspection, complete initial screen text step and position camera at center of cleanout and with axis at centerline of pipe.
 - 3. Before camera enters pipe, inspection shall provide internal video of cleanout. Video recording shall begin by facing pipe segment to be televised and then pan/tilt/zoom as necessary to point camera up towards cleanout opening.

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4. Show continuous footage reading on inspection image. Place on screen where it is clearly visible (if black font, do not place on dark background, if white font, do not place on light background).
5. Viewing shall be in direction of flow, except while camera is being used in a reverse setup. Inspection shall proceed from upstream to downstream, unless prohibited by obstruction.
6. If during inspection operation television camera will not pass through entire line segment due to obstruction, set up equipment so inspection can be performed from opposite cleanout.
7. If upstream (reverse) setup, is required, establish new inspection run separate from downstream (normal) setup.
8. Keep camera lens clean and clear. If material or debris obscures image or causes reduced visibility, clean or replace lens prior to proceeding with recording operation.
9. Camera lens shall remain above visible water level and may submerge only while passing through clearly identifiable line sags or vertical misalignments. If flow exceeds 25 percent of diameter, such that camera lens becomes obscured, stop inspection until flow subsides. If necessary, reschedule CCTV operation. Surcharging and flooding of camera lens is not an excusable condition if it has been artificially created upstream (for example, placement of flow plugs or freshwater flushing in pipe).
10. Recordings shall clearly show defects and observations, and their severity, in addition to obvious features, such as laterals and joints.
11. Immediately report to DEN Project Manager, any obstructions that restrict flow and cause inspection to be interrupted. Document condition with still photographs, and begin inspections of other pipelines.
12. Camera Operation:
 - a. Speed: 30 feet per minute, maximum, during inspection.
 - b. Stop, for a minimum of 5 seconds, at every lateral, or other defect or adversity.
 - c. Pan entire diameter or area of pipe at each defect and lateral connection.
 - d. Read just lens, lighting, and focus in order to ensure clear, distinct, and properly lighted image of defect.
13. Loss of color or severe red or green color will be cause for rejection of inspection.
14. Recordings shall be without distortion or outside interference.
15. Televisе line segments from structure-to-structure on same DVD in continuous run.
 - a. Video shall clearly show camera starting and ending at structure, unless

- defects do not allow it.
 - b. Do not perform partial televising on one DVD and then complete run on another DVD.
 - c. If line is partially televised, as a result of an excusable condition, (for example, collapsed line), televised length shall be viewed by DEN Project Manager for acceptability.
 - d. If portion of line is unacceptable, entire segment shall be deemed unacceptable and shall be retelevised.
16. DEN Project Manager may accept physical inspection that does not adhere to minimum standards if adverse conditions are encountered and reinspection is not advised. In such a case, enough data shall be provided to permit accurate assessment.

B. Measurement:

1. Record in English units.
2. Obtain pipe diameter by physical measurement in upstream (or downstream) access structure.
3. Verify pipe material and surface lengths between cleanouts.
4. Use calipers or measuring rod to determine diameter of inlet and outlet pipe.
5. Footage measurements shall begin at centerline of upstream manhole, unless DEN Project Manager approves otherwise.
6. Continuous Footage Readings:
 - a. Use to identify location of defects.
 - b. Accurate to within plus or minus 0.20 feet tolerance.
 - c. Defect identifications are to be called out and recorded to nearest 0.10 feet.
 - d. Line segment recording will be unacceptable if continuous footage meter is inaccurate, or identified defects or features leave doubt as to accuracy of locations or total length.
7. Measurement shall be zeroed after each segment inspected.

3.5 RECORDING OF DOCUMENTATION

- A. Upon completion of CCTV inspection post rehabilitation, transfer inspection data to DVD of sufficient capacity and compatibility with Owner's equipment; include code required for proper playback of video file.
1. Labeling:
 - a. Provide printed label on outside of DVD that indicates the following:
 - 1) Denver International Airport.
 - 2) Project title.
 - 3) Date of inspection.
 - 4) Inspection company.
 - 5) Range of pipe structure identification numbers included.

- B. Media:
1. Video:
 - a. Inspections completed, with a unique filename per inspection.
 - b. Encoded in .WMV, .MPG, or .AVI format.
 - c. Opening Screen: The following is an example of required on-screen text display fields:
 - 1) Date and Time: (YYYY/MM/DD), (military time hh:mm).
 - 2) Surveyor's Name/Company: John Doe/ABC Company.
 - 3) Project Name: XYZ project.
 - 4) Location: 1 Building.
 - 5) Location Code: Room#.
 - 6) Sump No: ### (Feature_ID or Facility_ID).
 - 7) Sump Type: ##.# (ie, industrial, footer, sanitary).
 - 8) Pump No: ### (Feature_ID or Facility_ID).
 - 9) Pipe Segment Ref. ##### (Feature_IDs, direction).
 - 10) Starting Footage: ###(nearest tenth of foot).
 - 11) Inspection Direction: Downstream or upstream.
 - 12) Pipe Material: Example, ductile iron.
 - 13) Pipe Diameter/Height/Width: Diameter: ##/COP Height below finished floor: ##/Width: ## (as measured in field).
 - 14) Weather: Example, snow, rain, dry.
 - 15) Precleaning: Example, jetting.
 - 16) Additional Information: Additional important information/comments. i.e.: Broken pipe/ distance.
 - d. Continuous View: Following is list of required on-screen text display fields:
 - 1) Inspection date and time.
 - 2) Continuous forward and reverse readout of cameral distance from center of manhole reference (tape counter footage).
 - 3) Pipe structure identification number.
 - 4) Defect/observation code(s) (when encountered).
 2. Audio:
 - a. Embedded in video file.
 - b. Operator shall include description of inspection setup, including related information from log form and unusual conditions.
 - c. Operation changes (for example, remove roots and restart inspection at footage prior to root removal).
 - d. Verbal description and location of each defect.
 - e. Verbal description and location of each service connection.
 3. Still Photographs:
 - a. Provide digital photographs showing inspection image whenever observation or defect is recorded.
 - b. Each with unique filename.
 - c. Encoded in .jpg format.
 - d. Minimum 640 by 480 resolution.

- e. Provide label on front of photograph with structure identification number, footage (if not visible on photograph), and defect code.

C. Inspection Reports:

- 1. Provide .PDF inspection reports including:
 - a. Summary of inspections completed. An example summary inspection report is shown as a supplement at the end of this section.
 - b. Pipe graphs of each inspection showing asset information and defects/observations.
- 2. Field Maps:
 - a. Corrected to reflect actual field conditions.
 - b. Illustrate changes in pipe routing that differ from anticipated network on Drawings. Indicate pipe number on drawings from on screen text log data above. Correlate data with drawings.
 - c. Neatly strike out incorrect data using green pencil and clearly mark in correct data, using red pencil. Show notes that clarify changes in blue pencil.

3.6 FIELD QUALITY CONTROL

- A. Review videos and reports to resolve inconsistent and conflicting data and to improve accuracy of data prior to submittal.
- B. If minimum level of accuracy is not met between videos and reports after review by DEN Project Manager, perform reinspection of pipes that do not meet requirements.
- C. Quality control procedures shall be in accordance with method attached as a supplement at the end of this section.

3.7 SUPPLEMENTS

- A. The supplements listed below part 4, Measurement and Payment are a part of this specification.
 - 1. Inspection Summary Sheet
 - 2. NASSCO PACP Quality Control

PART 4 MEASUREMENT AND PAYMENT

- 4.1 No measurement for payment is associated with this specification section. Work covered by this specification section shall be considered included in related bid items.

NASSCO PACP QUALITY CONTROL PROCEDURE

General Method

CCTV contracting companies shall have a Random Number Quality Control procedure in place that is then audited by client. A random number is one of a series of numbers that have no detectable pattern, so that each and every item in a known population has an equal chance of being selected based upon random number. A minimum of 5 percent of CCTV contractor's data shall be checked using a Random Number Quality Control procedure as basis of selecting inspections for review. Intent is for Client to actually audit CCTV contractor's QC procedure rather than performing their own QC. If there is doubt about results then Client can ask for another differing set of Random Numbers to be created and be applied to CCTV operator in question, thereby generating another different set of inspections to be checked. Create QC history for each CCTV operator and not for each contract.

Generating Random Numbers

A Random Number list, based upon population and selection percentage, is available from many web sites. This site generates a list of random numbers that can be sorted in numerical order and printed. Each CCTV operator shall have a different set of Random Numbers.

Selection of Inspections to be Checked

In the field, CCTV operator inspects each sewer segment and enters PACP information into a computer database. In the office, QC employee/operator counts through inspections, for each separate CCTV operator, in the order in which they were inspected. When inspection coincides with a Random Number a copy of inspection is made from HD/DVD onto CCTV operator's master QC HD/DVD. A copy of corresponding CCTV report is also printed from computer. These are then kept in CCTV operator's QC folder until QC is carried out by qualified QC employee/operator. By using the Random Number sampling system CCTV operator will not be able to "abuse" system. Client can ask for the set of Random Numbers for each CCTV operator at start of Project, or Client can provide a set of Random Numbers to be used for each operator associated with Project.

Quality Control of Inspection

It is expected that accuracy of Header record exceeds 90 percent as most field contents are based upon facts. The simplest method for QC of Header record is as follows:

Each field completed, and those that are not but should have been, is counted, producing a "number of fields checked", say 32 (ignoring unused fields).

Then fields with mistakes are counted, irrelevant of level of the mistake, creating an "error count" say for this example, 2.

Therefore, calculation is:

$$(\text{error count}/\text{number of fields checked}) * 100 = \text{percentage error } 100 - \text{error percentage} =$$

accuracy percentage

$$(2 / 32) * 100 = 6.25\%$$

$$100\% - 6.25\% = 93.75\% \text{ accuracy level}$$

This percentage accuracy level is then entered onto a graph so that ongoing accuracy can easily be seen, again, for each CCTV operator.

Detail Information

It is expected that accuracy of Observation/Defect codes exceed 90 percent.

As with Header records, each field that has been completed in the Detail records is added up, irrelevant of whether it is a Clock At/To, the Continuous Defect field or Distance/Video digits. Each entry is treated as equally important. From this number of entries made in the Detail section, a figure is arrived. A qualified QC employee/operator then looks through the same inspection and checks accuracy of each field and reaches two values, the number of entries that should have been made and an error count. No attempt should be made to create a new inspection from scratch, just check what has already been reported on. If a defect is not recorded then number of fields that support the missed defect is added to Error Count, for instance, if CCTV operator misses an EMJ then error count increases by at least five errors:

Video Digit, Distance, Code, Clock At and To and the percent

The five errors must also be added to number of entries that should have been made as well as any other errors to reach a total number of entries. Therefore at the end each inspection there are two values, the number of entries that should have been made and the error count. Calculation for Quality Control of each inspection is as follows:

$$(\text{Error Count} / \text{Number of entries that should have been made}) * 100 = \text{Percentage Error}$$

$$100 - \text{Percentage Error} = \text{Accuracy Level}$$

Assume number of entries made should have been 122 Assume Error

$$\text{Count is 8: } (8 / 122) * 100 = 6.5\%$$

$$100\% - 6.5\% = 93.5\% \text{ Accuracy Level}$$

This percentage Accuracy Level is then entered onto a graph so that ongoing level can be easily seen for each CCTV Operator.

Summary

QC inspection information for each sewer segment checked is entered into QC forms so that an Audit trail can be established. There must be hard copies of each inspection checked with Errors and Omissions clearly marked. Accuracy Level calculations must also be entered into QC logs. Random Number must be entered against each aspect of QC procedure. A continuing Accuracy Level Graph must be kept up to date for each CCTV operator; it is acknowledged that results could be as much as 1 month behind time of inspection.

END OF SECTION 220130.16

SECTION 033053 - MISCELLANEOUS CAST-IN-PLACE CONCRETE (LIMITED APPLICATIONS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 ACTION SUBMITTALS

- A. General: In addition to the following, comply with submittal requirements in ACI 301.
- B. Product Data: For each type of product indicated.
 - 1. Include data substantiating that materials comply with requirements.
- C. Other Action Submittal:
 - 1. Design Mixtures: For each concrete mixture.

1.4 CLOSEOUT SUBMITTALS

- A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in service performance.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready mixed concrete products complying with ASTM C 94 requirements for production facilities

and equipment.

- C. Source Limitations: Obtain each type of cement of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- D. Ready Mix Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- E. Comply with the following sections of **ACI 301**, unless modified by requirements in the Contract Documents:
 - 1. "General Requirements."
 - 2. "Formwork and Formwork Accessories."
 - 3. "Reinforcement and Reinforcement Supports."
 - 4. "Concrete Mixtures."
 - 5. "Handling, Placing, and Constructing."
 - 6. "Lightweight Concrete."
- F. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

1.6 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 FORMWORK

- A. Furnish formwork and formwork accessories according to ACI 301.

2.2 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than **25**percent.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- C. Plain Steel Wire: ASTM A 82/A 82M, as drawn.
- D. Plain Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as drawn steel wire into flat sheets.
- E. Deformed Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150, **Type II. Supplement with the following:**
 - a. Fly Ash: ASTM C 618, Class C or F.
- B. Normal Weight Aggregate: ASTM C 33, graded, 1-1/2 inch nominal maximum aggregate size.
- C. Water: ASTM C 94/C 94M.

2.4 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water soluble chloride ions by mass of cement and to be compatible with other admixtures.
- B. Air Entraining Admixture: ASTM C 260.
- C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High Range, Water Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High Range, Water Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 RELATED MATERIALS

- A. Joint Filler Strips: ASTM D 1751, asphalt saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.
- B. Fine Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

- B. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.
- C. Moisture Retaining Cover: ASTM C 171, polyethylene film or white burlap polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane Forming Curing Compound: ASTM C 309, Type 1, Class B.
- F. Clear, **Waterborne**, Membrane Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.7 CONCRETE MIXTURES

- A. Comply with **ACI 301** requirements for concrete mixtures.
- B. Normal Weight Concrete: Prepare design mixes, proportioned according to **ACI 301**, as follows:
 - 1. Minimum Compressive Strength: **4500 psi** at 28 days.
 - 2. Maximum Water Cementitious Materials Ratio: **0.45**.
 - 3. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
 - 4. Slump Limit: **4 inches for concrete with verified slump of 2 to 4 inches before adding high range water reducing admixture or plasticizing admixture**, plus or minus **1 inch**.
 - 5. Add air entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 2.5 to 4.5 percent.
 - 6. Add air entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 6.0 percent within a tolerance of plus 1.0 or minus 1.5 percent.
 - 7. Air Content: Maintain within range permitted by **ACI 301**. Do not allow air content of trowel finished floor slabs to exceed 3 percent.

2.8 CONCRETE MIXING

- A. Ready Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes.
 - 2. When air temperature is above **90 deg F**, reduce mixing and delivery time to 60 minutes.
- B. Project Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, construct, erect, brace, and maintain formwork according to ACI 301.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.4 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Locate and install so strength and appearance of concrete are not impaired, at locations indicated or as approved by DIA Project Manager.

3.5 CONCRETE PLACEMENT

- A. Comply with ACI 301 for placing concrete.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- C. Do not add water to concrete during delivery, at Project site, or during placement.

- D. Consolidate concrete with mechanical vibrating equipment.

3.6 FINISHING FORMED SURFACES

- A. Rough Formed Finish: As cast concrete texture imparted by form facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding **1/4 inch**.
 - 1. Apply to concrete surfaces **not exposed to public view**.
- B. Smooth Formed Finish: As cast concrete texture imparted by form facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Completely remove fins and other projections.
 - 1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, damp proofing, veneer plaster, or painting.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.7 FINISHING UNFORMED SURFACES

- A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open textured surface plane before excess moisture or bleedwater appears on surface.
 - 1. Do not further disturb surfaces before starting finishing operations.
- C. Scratch Finish: Apply scratch finish to surfaces indicated and surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes, unless otherwise indicated.
- D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid applied or sheet waterproofing, fluid applied or direct to deck applied membrane roofing, or sand bed terrazzo.
- E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film finish coating system.

- F. Trowel and Fine Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin set methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- G. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber bristle broom perpendicular to main traffic route.

3.8 TOLERANCES

- A. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

3.9 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold weather protection and with **ACI 301** for hot weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching **0.2 lb/sq. ft. x h** before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with **12 inch** lap over adjacent absorptive covers.
 - 2. Moisture Retaining Cover Curing: Cover concrete surfaces with moisture retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least **12 inches**, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected

to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests: Perform according to **ACI 301**.
 1. Testing Frequency: One composite sample shall be obtained for each day's pour of each concrete mix.

3.11 REPAIRS

- A. Remove and replace concrete that does not comply with requirements in this Section.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 033053

SECTION 220131 - SEWER PIPE POINT REPAIRS AND OBSTRUCTION REMOVALS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Repair of sanitary sewers by replacing short lengths of failed pipe with new pipe.
- B. Repair of service lines by replacing short lengths of failed pipe with new pipe.
- C. Obstruction removal by remote device or excavation.

1.2 DEFINITIONS

- A. Point Repair: Repair of broken or collapsed gravity sanitary sewer lines, including mains, collectors and service lines, by replacing, at the point of failure, the length of failed pipe with new pipe.
- B. Obstruction Removal: Clearing sewer mains of obstructions to allow for rehabilitation.
- C. Sewer Lines: Gravity flow pipe lines which collect sanitary sewer discharges from service lines and discharge into another sewer line (main or collector), or into a lift station or treatment plant.
- D. Service Lines: Those gravity flow sewer lines from commercial buildings that discharge into a sewer line.

1.3 PERFORMANCE REQUIREMENTS

- A. Point Repair:
 - 1. Locate and replace small lengths of one or more pipe sections where isolated line failure has occurred due to settlement, corrosion, crushing, or separation of joints, or other significant defect.
 - 2. The DEN Project Manager may identify potential locations for point repair, but the Contractor is responsible for verifying locations. Point repairs to sewer lines are listed as shown in the Drawings.
 - 3. Determine the location of point repairs by closed circuit television (CCTV) inspection of the failed pipe location per Section 220130.16 Television Inspection of Sewer Pipelines.
- B. Obstruction Removal: Remove obstructions by one of the following methods:
 - 1. Obstruction removal by remote device:
 - a. Protruding taps: Service lines that protrude more than one inch into the sewer.

- b. Other obstructions: Hanging gaskets, fixed debris, stabilized sand, hardened mineral deposits, roots, rust scale, tuberculation, etc.
- 2. Obstruction removal by excavation: Obstructions encountered during liner insertion that are removed by digging and exposing the pipe.

1.4 SUBMITTALS

- A. Submit product data for each pipe product, fitting and jointing material.
- B. Submit Post-Inspection video in accordance with Section 220130.16 Television Inspection of Sewer Pipelines.

1.5 SEQUENCING

- A. Complete obstruction removal on the section of pipe that is to be replaced.
- B. Establish temporary flow control per Specification Section 225728 Temporary Flow Control.
- C. Complete point repair as identified on the Drawings.
- D. Remove temporary flow control once the point repair has been replaced and backfilled.

PART 2 PRODUCTS

2.1 PVC PIPE

- A. 15-Inch Diameter and Smaller:
 - 1. In accordance with ASTM D3034.
 - 2. Joints: Integral bell and spigot, in accordance with ASTM D3212.
 - 3. Minimum SDR: 26.
 - 4. Cell Classification: 12454-B or 12454-C, as defined by ASTM D1784.
 - 5. Fittings: SDR 35 minimum wall thickness.
 - 6. Gaskets: Factory fabricated rubber compression type with solid cross section in accordance with ASTM F477. Lubricant for joining pipe as approved by pipe manufacturer.

2.2 JOINTING MATERIALS

- A. Use flexible adapters secured with 1/2-inch stainless steel bands, as manufactured by Fernco, or approved equal.

PART 3 EXECUTION

3.1 PROTECTION

- A. Provide barricades, warning lights and signs for excavations created by point repairs as identified on the traffic control sheets for landside.
- B. Do not allow soil, sand, debris or runoff to enter sewer system during repair.

3.2 BYPASS PUMPING

- A. Install and operate bypass pumping equipment as required to maintain sewage flow and to prevent backup or overflow. Comply with Section 225728 – Temporary Flow Control.

3.3 EXCAVATION

- A. Excavate and backfill trenches in accordance with Division 31 Section 31 23 33 - Trenching and Backfilling. Point repairs in unimproved areas are to be backfilled with flowfill and native material. Point repairs in paved or concrete areas are to be backfilled with CLSM.
- B. Perform work in accordance with OSHA standards.
- C. Install and operate necessary dewatering and surface water control measures as required.
- D. Remove and lawfully dispose of excess excavated material and debris from the work site daily.

3.4 TYPICAL SEQUENCE OF POINT REPAIR

- A. Perform pre-installation video inspection to verify the location of sewer line point repairs. Perform service testing between cleanouts to verify location of service line point repairs.
- B. After the location of a point repair, excavate the required length for the point repair.
- C. Prior to replacing pipe, determine condition of the existing line on both sides of the point repair by lamping the line at least 10 feet in each direction. Determine whether additional lengths of line (beyond "minimum length" criteria) need replacement.
- D. Excavate and remove the damaged pipe, replace with new pipe, shaping the bottom of the trench and placing the required pipe bedding so that the grade of the replaced pipe matches the grade of the existing line.
- E. Connect the new pipe to sound, unbroken existing pipe using flexible adapters. If joints cannot be made watertight using flexible adapters, place waterstop gaskets on each joint and encase in a reinforced concrete collar. Reconnect affected service connections or stacks using full-bodied fittings. No field fabrication of fittings allowed.
- F. Backfill the excavation and complete site restoration as specified in Division 31.

- G. Perform a post-installation video inspection as specified in Section 220130.16 Television Inspection of Sewer Pipeline. Point repairs that show offset joints, non-uniform grade, incorrect alignment, excessive deflection or similar conditions are considered defective work. Replace pipe and bedding as required to correct defective work.
- H. Extra length of Pipe Replacement beyond the Point Repair limits may be extended to the entire section either way, even to the next continuous section, as directed by the DEN Project Manager.

3.5 OBSTRUCTION REMOVAL

- A. Remote Device: Remove obstructions identified during video inspection of a sanitary sewer line segment which could cause a non-uniform liner pipe installation or obstruction of the liner during installation. Obtain authorization from the DEN Project Manager for obstruction removal with a remote device before proceeding.
 - 1. Use a power-driven cutting device (robotic cutter) to remove protruding taps. Cut protruding taps so that protrusions are no greater than 3/4 inch. If a protruding tap cannot be removed by the cutting device, then a point repair may be performed. Obtain authorization from the DEN Project Manager before proceeding.
 - 2. To remove other obstructions, use a remote device. Pull or drive the device from cleanout to cleanout up to a continuous length of 500 feet using a solid steel mandrel, porcupine, root saw, bucket, robotic cutter or similar device to remove the obstruction. Select a device that is adequately sized to remove the obstruction.
- B. Excavation: Use excavation as the method of obstruction removal when installation of the liner in the sanitary sewer is in progress. If during the liner insertion operation, a collapsed sewer, off-set joint or other obstruction is encountered which prevents or blocks the passage or insertion of the liner, notify the DEN Project Manager for authorization to excavate. Uncover and remove the obstruction as follows:
 - 1. Excavate at the point where there is an obstruction. Use a trench safety system as required.
 - 2. Break out the minimum amount of existing sanitary sewer pipe (carrier pipe) as needed. Remove only that amount of material which is causing the obstruction.

PART 4 MEASUREMENT AND PAYMENT

4.1 Measurement and payment are as follows:

- A. Point repairs are to be measured on a lump sum basis per repair and includes

furnishing all equipment, labor, and materials necessary for repair of the cleanout or pipeline as listed in the Design Analysis Manual, including but not limited to CCTV, flushing the line as needed, excavation, removing and hauling the existing segment of pipe, installing a new section of pipe, fittings, backfilling, importing or hauling backfill material, and surface restoration to the satisfaction of the DEN Project Manager. Pay item includes all other work necessary to complete the installation per the Drawings and as specified.

END OF SECTION 220131

SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes construction dewatering.
- B. Related Requirements:
 - 1. Section 013233 "Photographic Documentation" for recording preexisting conditions and dewatering system progress.
- C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 NOT USED

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at location and time as determined by DEN Project Manager.
 - 1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review condition of site to be dewatered including coordination with temporary erosion-control measures and temporary controls and protections.
 - 3. Review as-built drawings and existing geotechnical reports.
 - 4. Review proposed site clearing and excavations.
 - 5. Review existing utilities and subsurface conditions.
 - 6. Review observation and monitoring of dewatering system.

1.5 ACTION SUBMITTALS

- A. Shop Drawings: For dewatering system.
 - 1. Include plans, elevations, sections, and details.

2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.
5. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and professional engineer.
- B. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.
- C. Field quality-control reports. Before starting excavation, submit test results and computations demonstrating that dewatering system is capable of meeting performance requirements.
- D. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.
- E. CLOSEOUT SUBMITTALS
- F. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".
 1. Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

1.7 QUALITY ASSURANCE

- A. A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.
- B. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems and dewatering work.

1.8 FIELD CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by DEN Project Manager and then only after arranging to

provide temporary utility services according to requirements indicated.

- B. Project-Site Information: No geotechnical report has been prepared for this Project. Existing as-built drawings and geotechnical report(s) are available for information only. The opinions expressed in available reports are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.
1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify DEN Project Manager if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

1.9 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
 2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
 3. Prevent surface water from entering excavations by grading, dikes, or other means.
 4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
 5. Remove dewatering system when no longer required for construction.

- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from DEN Project Manager and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Provide temporary grading to facilitate dewatering and control of surface water.
- D. Protect and maintain temporary erosion and sedimentation controls during dewatering operations.

3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
 - 1. Space well points or wells at intervals required to provide sufficient dewatering.
 - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.
- C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

- D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
 - 2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.
- C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.
- D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.
- E. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.4 FIELD QUALITY CONTROL

- A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.
 - 1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
 - 2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
 - 3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

- B. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify DEN Project Manager if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.
- C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.
- D. Prepare reports of observations.

3.5 PROTECTION

- A. Protect and maintain dewatering system during dewatering operations.
- B. Promptly repair damages to adjacent facilities caused by dewatering.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 312319

SECTION 312333 - TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Excavating and backfilling trenches for utilities and pits for buried utility structures.
2. Furnish all labor, materials, equipment, and incidentals necessary to perform all trenching for pipelines and appurtenances, including drainage, filling, backfilling, disposal of surplus material, and restoration of trench surfaces.
3. Comply with all requirements of the most recent issue of OSHA defined in the Federal Register, and all other rules and regulations. In the case of conflict between these specifications and OSHA rules and regulations, OSHA will take precedence.
4. Bedding shall be utilize flowable backfill material.
5. All excavation, trenching, and related sheeting, bracing, etc., shall comply with the requirements of the Occupational Safety and Health Act's (OSHA) excavation safety standards (29 CFR 1926.650 Subpart P) and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.
6. Excavation shall extend to the width and depth as required to provide suitable room for installing pipe, structures, and appurtenances.
7. The Contractor shall furnish and place all sheeting, bracing, and supports and shall remove from the excavation all materials that the Engineer of Record may deem unsuitable for backfilling. The bottom of the excavation shall be firm, dry, and in all respects, acceptable. If conditions warrant, the Contractor may be ordered to deposit gravel or gravel refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever. The length of open trench shall be related closely to the rate of pipe laying.
8. Where utilized herein, the following definitions shall apply (not all types of pipe listed may be utilized in this project):
 - a. Rigid (Wall) Pipe: Reinforced concrete, ductile iron, vitrified clay.
 - b. Flexible (Wall) Pipe: Steel, corrugated metal, plastic, PVC, HDPE.

B. Related Sections:

1. Section 011400 "Work Sequence and Constraints".
2. Section 013510 and 013520 "Construction Safety" and "Construction Safety-Airside" for safety procedures.
3. Section 013233 "Photographic Documentation" for recording preexcavation and earth moving progress.
4. Section 013300 "Submittal Procedures" for submittal requirements.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 DEFINITIONS

A. Backfill: Soil material or Controlled Low-Strength Material (CLSM) (flowable backfill) used to fill an excavation:

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe. Initial backfill with flowable backfill shall not exceed the center of the pipe and in no time shall cause the pipe to float or varies from the slope and alignment intended to assure proper functioning of the utility carrier.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.
3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by DEN Project Manager. Unauthorized excavation, as well as remedial work directed by the DEN Project Manager, shall be without additional compensation.

B. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:

1. Controlled Low-Strength Material (flowable backfill), including design mixture.
2. Warning tapes.
3. Include data substantiating that materials comply with requirements.

B. Samples for Verification: For the following products, in sizes indicated below:

1. Warning Tape: 12 inches long; of each color.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each material proposed for backfill as follows:

1. Classification according to ASTM D 2487.
2. Laboratory compaction curve according to ASTM D 698 or ASTM D 1557.

C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by trenching operations. Submit before trenching begins.

1.6 QUALITY ASSURANCE

- A. Comply with all requirements of the most recent issue of OSHA defined in the Federal Register, and all other rules and regulations. In the case of conflict between these specifications and OSHA rules and regulations, OSHA will take precedence.
- B. Preexcavation Conference: Conduct conference at location and time as determined by **DEN** Project Manager.

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjacent occupied or used facilities during trenching operations.
1. Do not close or obstruct adjacent occupied or used facilities without approved shutdown request submitted in accordance with Section 011400.
 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify "**Call Before You Dig**" for area where Project is located before beginning trenching operations, as required by Section 011810 of the General Requirements.
- C. The following practices are prohibited within protection zones:
1. Storage of debris or excavated material.
 2. Parking personal vehicles or any vehicles or equipment that are not part of the construction means.
 3. Erection of sheds or structures.
 4. Impoundment of water, icing or snow unless authorized by the DEN Project Manager.
 5. Excavation or digging unless otherwise indicated.
- D. Do not direct vehicle or equipment exhaust towards protection zones.
- E. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

1.8 CONSTRUCTION WASTE MANAGEMENT

- A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Unless otherwise noted, the following shall apply:

1. Pipe Embedment:

a. Definitions:

- 1) All pipe: Material placed within the limits of the pipe trench below the pipe, to support it, up to the springline (centerline) of the pipe.
- 2) For all rigid pipe of 24-in diameter or less, and all flexible wall pipe: bedding shall also include all material surrounding the pipe, inside the limits of the pipe trench, extending to the height noted above the pipe, and below the backfill.

- b. Embedment Materials: Controlled Low Strength Material (flowable backfill), unless otherwise noted.

2. Initial Backfill:

- a. Definition: For rigid pipes with diameter larger than 24-in, this shall be the material placed from the top of the bedding, inside the limits of the pipe trench, extending to the height noted above the pipe and below the backfill.
- b. Initial Backfill Material: Controlled Low Strength Material (flowable backfill).

3. Backfill or Pipe Backfill:

- a. Definition: All material above the bedding or initial backfill.
- b. Backfill Materials: Controlled Low Strength Material (flowable backfill) is required whenever backfilling utility trenches, with other modification noted in certain areas, such as trench restoration with previously existing lean concrete, and cement treated base material with equivalent material.

4. Pipe Foundations and Other Materials: Their uses in trenches will be specified in this Section, but the material itself is specified in the Section noted in paragraph 1.2.

- B. For material not specified herein, see the appropriate Sections noted in paragraph 1.2.

2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain system until dewatering is no longer required.

3.3 TRENCH EXCAVATION, GENERAL

- A. Trench excavation shall include material of every description and of whatever substance encountered, including rock and boulders. Floor structure and surfaces shall not be cut without approval of DEN Project Manager.
- B. Trenches shall be excavated to the depth and in widths sufficient for laying the pipe, bracing, and for pumping and drainage facilities. The bottom of the excavations shall be firm and dry and, in all respects, trench width shall be practical minimum.
- C. Pipe Foundation:
 1. In all places where the bottom of the trench excavation is wet, soft, or unstable and cannot satisfactorily support the pipe, unsatisfactory material shall be removed and recompacted fill placed to grade. Bridging or stabilization by means of crushed stone or 3"-6" rock or recycled material is permissible.

3.4 PROTECTION

- A. Sheeting and Bracing in Trench Excavation:
 1. Furnish, install, and maintain such sheeting and bracing as may be required to support the sides of excavations to prevent any movement that could in any way diminish the width of the excavation below that necessary for proper construction and to protect adjacent structures from undermining or other damage. Prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.
 2. Leave in place, to be embedded in the backfill, all sheeting and bracing that the Owner may require, in writing, to be left in place at any time during the progress of the Work for the purpose of preventing injury to structures, utilities, or property, whether public or private. The DEN Project Manager may direct that sheeting and bracing be cut off at any specified elevation.
 3. All sheeting and bracing not left in place shall be carefully removed in such a manner as not to endanger the construction or other structures, utilities, or property. All voids left or caused by withdrawal of sheeting shall be immediately refilled with Controlled Low Strength Material (flowable backfill) or otherwise as may be directed.
 4. The Contractor will be permitted to use steel sheeting in lieu of wood sheeting for the entire job wherever the use of sheeting is necessary. The cost for use of sheeting will be included in the bid items for pipe and shall include full compensation for driving, bracing, and later removal of sheeting.

3.5 MATERIALS HANDLING

- A. Stack excavated material without excessive surcharge.
- B. Should conditions make it impracticable or unsafe to stack material adjacent to the trench, the material shall be hauled and stored at a location provided by the Contractor.

3.6 EXCAVATION BELOW NORMAL PIPE TRENCH BOTTOM GRADE

- A. Whatever the nature of unstable material encountered or the groundwater conditions, trench drainage shall be complete and effective. Avoid sudden drawdown of ground water table.
- B. If the Contractor excavates below grade through error or for Contractor's own convenience, or through failure to properly dewater the trench, or disturbs the subgrade before dewatering is sufficiently complete, the Contractor may be directed to over-excavate below grade and replace with flowable backfill (CLSM), in which case the work of excavating below grade and furnishing and placing the refill shall be performed at the Contractor's own expense.
- C. If the material at the level of trench bottom consists of fine sand, sand and silt, or soft earth that may work into the screened gravel notwithstanding effective drainage, the subgrade material shall be removed and a pipe foundation utilized as noted previously.
- D. Where the trench bottom has been excavated below grade, the trench shall be refilled with a pipe foundation as noted previously.

3.7 PIPE BEDDING

- A. Bedding materials both below and above the bottom of the pipe shall consist of a flowable backfill and conform to the requirements in individual pipe specifications or as noted below.
- B. Unless otherwise noted on the Drawings, the following shall apply:
 - 1. Height of bedding required:
 - a. Rigid Pipe: Minimum trench bottom to springline.
 - b. Flexible Pipe: Minimum trench bottom to springline.

3.8 BACKFILLING (INCLUDING INITIAL BACKFILL)

- A. Unless otherwise noted, all pipe backfilling material shall be as follows:
 - 1. Flowable backfill shall be used to backfill all utilities bedding material with the

- exception of foundation drainage pipes and concrete duct banks.
2. Flowable backfill shall be used to backfill all trenches under structures, pavement, roadway shoulders, sidewalks and any backfill of trenches adjacent to building structures within five (5) feet of the building.
 3. Flowable backfill shall be used to replace soft or unsuitable muck, naturally deposited soil cuts, cement treated soil, structural backfill, lime treated soils, granular subgrades, or compacted backfill soil material.
 4. Flowable backfill cannot replace the following:
 - a. Regular strength concrete.
 - b. Cement treated base.
 - c. Asphalt concrete.
 - d. Lean concrete or any material having a compressive strength higher than 100 psi.

3.9 RESTORING TRENCH SURFACE

- A. The Contractor shall thoroughly consolidate the backfill and shall maintain the surface as the work progresses. If settlement takes place, the Contractor shall immediately deposit additional fill to restore the level of the ground.
- B. The surface of any area that is disturbed by the trench excavation shall be restored by the Contractor to a condition at least equal to that existing before work began.
- C. It is acceptable to replace Lime Treated Soil or Cement Treated Soil or granular material with flowable backfill unless otherwise noted on the drawings.

3.10 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
 2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain system until dewatering is no longer required.
 3. Avoid sudden drawdown condition causing unbalanced water pressure and failure of trench sides.
 4. Remove softened soils caused by water or bridge the soft material with gravel and small boulder material as necessary and as approved by the DEN Project Manager.

3.11 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C. Where settling occurs before Project correction period elapses, backfill with additional Controlled Low Strength Material (flowable backfill).

3.12 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
- B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by the DEN Project Manager.
 - 1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
 - 2. All waste material deposited off DEN property must be dumped at DAD as specified in Technical Specification Section 015700.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

- A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the applicable unit price item, work order, or lump sum bid item.

END OF SECTION 312333