

## TABLE OF CONTENTS

### CHAPTER 9 TRENCHING, BACKFILLING, AND COMPACTING

|                | Page  |
|----------------|---|
| <b>9.00.00</b> | <b><u>GENERAL</u>..... 9-1</b>                                    |
| 9.01.00        | DESCRIPTION ..... 9-1   |
| 9.02.00        | QUALITY ASSURANCE ..... 9-1                                       |
|                | 9.02.01 <u>Compaction</u> ..... 9-1                               |
|                | 9.02.02 <u>Construction Staking</u> ..... 9-1                     |
| 9.03.00        | JOB CONDITIONS ..... 9-1  |
|                | 9.03.01 <u>Drainage and Groundwater</u> ..... 9-1                 |
|                | 9.03.02 <u>Sequencing</u> ..... 9-2                               |
|                | 9.03.03 <u>Underground Obstructions</u> ..... 9-2                 |
| 9.04.00        | MAINTENANCE AND CORRECTION..... 9-3                               |
|                | 9.04.01 <u>Trench Settlement</u> ..... 9-3                        |
|                | 9.04.02 <u>Subcontractors</u> ..... <b>9-3</b>                    |
| <b>9.10.00</b> | <b><u>CONSTRUCTION SPECIFICATIONS</u> ..... 9-3</b>               |
| 9.11.00        | PREPARATION ..... 9-3   |
| 9.12.00        | TRENCHING ..... 9-3   |
| 9.13.00        | PIPE BEDDING ..... 9-5  |
| 9.14.00        | BACKFILLING AND COMPACTION ..... 9-5                              |
| 9.15.00        | FIELD QUALITY CONTROL ..... <b>9-6</b>                            |
| 9.16.00        | EXCAVATIONS AND REMOVALS WITHIN EXISTING PAVED SURFACES ..... 9-7 |
| <b>9.20.00</b> | <b><u>MATERIAL SPECIFICATIONS</u>..... <b>9-8</b></b>             |
| 9.21.00        | STABILIZATION MATERIAL ..... 9-8                                  |
| 9.22.00        | BEDDING MATERIALS ..... 9-8                                       |
| 9.23.00        | TRENCH BACKFILL MATERIAL ..... 9-9                                |
| 9.24.00        | FLOW-FILL/FLOWABLE FLY ASH BACKFILL ..... 9-9                     |
|                | 9.24.01 <u>General</u> ..... 9-9                                  |
|                | 9.24.02 <u>Compaction</u> ..... <b>9-10</b>                       |

**CHAPTER 9**  
**TRENCHING, BACKFILLING AND COMPACTING**

**9.00.00**      **GENERAL**

**9.01.00**      **DESCRIPTION**

- (A) This section covers excavation and trenching including drainage, dewatering, preparation of subgrades, pipe bedding, backfilling, compacting, and finish grading for underground pipe lines, service lines, and appurtenances.
- (B) Reference detail drawing in the appropriate chapter of these STANDARDS AND SPECIFICATIONS.

**9.02.00**      **QUALITY ASSURANCE**

**9.02.01**      **Compaction**

Soil compaction tests shall be performed in accordance with:

- (A) ASTM D 698, Standard Method of Test for Moisture Density Relations of Soils
- (B) ASTM D 2049, Standard Method of Test for Relative Density of Cohesionless Soils

**9.02.02**      **Construction Staking**

- (A) Construction staking shall be performed with qualified, competent personnel under the direction of a professional land surveyor registered in the State of Colorado.
- (B) All survey notes and construction staking notes shall be entered into bound, hard cover field books.
- (C) Staking of the work shall be at fifty-foot (50') stations (maximum).
- (D) Offsets shall be staked so that vertical and horizontal alignment may be checked.
- (E) All survey data which is developed by the contractor or the developer's surveyor in performing surveys which are required by the work shall be available to the City for examination throughout the construction period.

**9.03.00**      **JOB CONDITIONS**

**9.03.01**      **Drainage and Groundwater**

- (A) All excavations and trenches shall be kept free from excess groundwater during construction.
- (B) Any water which is encountered in the trench shall be removed to the extent necessary to provide a firm subgrade to permit joints to be made in the dry and to prevent the entrance of water into the pipeline.

- (C) Surface run-off shall be diverted as necessary to keep excavations and trenches free from water during construction.
- (D) The excavation or trench shall be kept free from water until the structure or pipe to be installed therein is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
- (E) Water shall be prevented from entering into previously constructed pipe.
- (F) Except for storm drains, the pipe under construction shall not be used for dewatering.

**9.03.02 Sequencing**

- (A) Pipeline installation shall be performed within two hundred (200) linear feet of trench excavation. If construction is occurring in an open field, this distance may be increased at the Public Works Director/City Engineer's discretion.
- (B) Initial trench backfill shall be performed within fifty (50) linear feet of pipeline installation. If construction is occurring in an open field, this distance may be increased at the Public Works Director/City Engineer's discretion.
- (C) Where excavation is a hazard to automotive or pedestrian traffic, the amount of open trench and the duration of that opening is to be minimized. The contractor shall coordinate the amount and duration of road closures with the City's Public Works and Traffic Department.

**9.03.03 Underground Obstructions**

- (A) The contractor/developer shall field verify all drawings of record information obtained from the City or other affected utility company.
- (B) The contractor/developer shall notify each utility owner and request utilities to be field located by surface reference at least forty-eight (48) hours prior to trenching or excavation.
- (C) In situations where conflicts may exist, the contractor shall expose and verify the size, location, and elevation of underground utilities and other obstructions sufficiently in advance of construction to permit changes to be made to the construction drawings.
- (D) In the case of a conflict, the contractor shall notify the City and the affected utility company, the proposed work may then be modified by the Design Engineer and after the Public Works Director/City Engineer's approval.
- (E) Existing improvements, adjacent property, utilities, trees, and plants that are not to be removed shall be protected from injury or damage resulting from the contractor's operations. If damage should occur, the contractor shall make repair such that damaged materials are restored in original or better condition, as directed by the Public Works Director/City Engineer, utility or property owner in question.
- (F) If the contractor removes any underground obstructions, the following shall apply:

1. Drainage culverts may be salvaged, stored, and reused in the original location if approval is obtained from the City Engineer. All other underground obstructions shall be replaced with new materials.
2. The area in which the underground obstruction was located shall be restored to original or better condition.

#### **9.04.00 MAINTENANCE AND CORRECTION**

##### **9.04.01 Trench Settlement**

The contractor/developer shall maintain and repair all trench settlement and make necessary repairs to pavement, sidewalks, or other structures which may be damaged as a result of backfill settlement. Contractor shall warrant work for a period of one (1) year after final completion and acceptance of the work.

##### **9.04.02 Subcontractors**

The contractor/developer may perform such maintenance and repairs by subcontract. If the contractor chooses to subcontract the warranty work, he shall submit to the Public Works Director/City Engineer a copy of the subcontract or the work authorization as evidence of the contractor's faithful intention to perform any repairs which may become necessary during the one-(1) year warranty period.

#### **9.10.00 CONSTRUCTION SPECIFICATIONS**

##### **9.11.00 PREPARATION**

- (A) Topsoil shall be stripped from areas which are to be disturbed by construction and stockpiled.
- (B) Topsoil shall be segregated from non-organic trench excavation material and debris.

##### **9.12.00 TRENCHING**

- (A) Trenches shall be excavated by open-cut methods, except where boring or tunneling is indicated, shown on drawings, or approved by the Public Works Director/City Engineer.
- (B) Trench width shall be maintained to within three inches (3") of that specified on plans.
- (C) Care shall be used when operating mechanical equipment in locations where it may cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground.
- (D) Mechanical equipment shall be designed and operated in such a manner that the bottom elevation of the trench can be controlled with uniform trench widths and vertical sidewalls which extend from the bottom of the trench to an elevation one foot (1') above the top of the installed pipe.

- (E) Trench alignment shall be sufficiently accurate to permit pipe to be aligned properly with an eight-inch (8") minimum clearance between the pipe and the sidewalls of the trench. The trench sidewall shall not be undercut in order to obtain clearance.
- (F) Contractor shall over-excavate a minimum of six inches (6") below the bottom of the pipe wherever the trench bottom is rock, shale, or other unsuitable material. Over-excavation shall be backfilled and compacted with acceptable granular material. Granular material shall conform to Section 9.22.00 of these STANDARDS AND SPECIFICATIONS.
- (G) Preparation of Trench Bottom:
1. Trench bottoms shall be graded uniformly to provide clearance for each section of pipe.
  2. Loose material, water, and foreign objects shall be removed from the trench.
  3. The contractor shall provide a firm subgrade which is suitable for application of bedding material.
  4. Wherever unstable material is encountered in the bottom of the trench, said material shall be over-excavated to a depth suitable for construction of a stable subgrade. The depth suitable for construction of a stable subgrade shall be determined by the Public Works Director/City Engineer. The over-excavation shall be backfilled with stabilization material and compacted as required by the Public Works Director/City Engineer. Stabilization material shall conform to Section 9.21.00 of these STANDARDS AND SPECIFICATIONS.
- (H) Stockpiling Excavated Materials:
1. Suitable material for backfilling shall be stockpiled in an orderly manner at a minimum of four feet (4') from the edge of the trench.
  2. Excess excavated materials not suitable or not required for backfilling shall be removed from the site and disposed.
  3. Excavated material shall not be stockpiled against existing structures or appurtenances.
  4. Excavated materials containing any hazardous materials shall be disposed of at an approved site in accordance with an abatement plan to be prepared by the developer/engineer or other qualified professional in accordance with all federal, state, and local ordinances.
- (I) Limiting Trench Widths:
1. Trenches shall be excavated to a width necessary to provide an eight-inch (8") minimum working space between the pipe and the trench walls for proper pipe installation, joining, and bedding.
  2. The maximum trench width at an elevation twelve inches (12") above the top of the installed pipe shall be the pipe diameters of the pipe plus 24 inches, or thirty inches (30") whichever is greater. If the width of the trench, twelve inches (12") above the top of the pipe, exceeds the maximum allowable trench width, a higher strength pipe or special pipe

bedding shall be provided as required by soil-loading conditions and as approved by the Public Works Director/City Engineer.

**9.13.00 PIPE BEDDING**

(A) Placement and Compaction:

1. Bedding material shall be distributed and graded to provide uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. Pipe shall not be supported by the bells.
2. To prevent lateral displacement, granular bedding material shall be deposited and compacted uniformly and simultaneously on each side of the pipe.
3. Granular bedding material shall be compacted in accordance with these STANDARDS AND SPECIFICATIONS.

(B) Ground water barriers shall be constructed in such a manner to prevent passage of water through bedding material for the full depth of the granular bedding material and the full width of the trench.

1. Ground water barriers, if shown on the approved construction plans, shall be approximately four feet (4') long and spaced not more than four hundred feet (400') apart.
2. Material for ground water barriers shall be as specified by the ditch company which controls the irrigation ditch to be crossed. If there is no ditch company, the Public Works Director/City Engineer shall determine the material to be used.

**9.14.00 BACKFILLING AND COMPACTION**

- (A) Trenches shall be backfilled promptly after the pipe has been installed and inspected. Backfill around manholes and valve boxes shall be compacted with hand-operated equipment.
- (B) Backfill material shall be deposited in uniform horizontal layers which may not exceed six inches (6") (compacted depth) in all areas. Other thickness may be used with the prior written approval of the Public Works Director/City Engineer.
- (C) Methods and equipment which are appropriate for the backfill of material shall be employed. Backfill equipment or backfilling methods which transmit damaging shocks to the pipe shall not be used.
- (D) Compaction shall not be performed by jetting or water settling.
- (E) If compaction cannot be obtained with job excavated material, trench backfill material shall be imported.
- (F) Topsoil shall be replaced to the depth of stripping over all areas which are to receive vegetation.
- (G) Excess excavated materials and materials not suitable for backfill shall be removed from the site.

## 9.15.00

### FIELD QUALITY CONTROL

(A) Field Compaction Control:

1. Field tests will be conducted to determine compliance of compaction methods with specified density in accordance with ASTM D 2922 (Tests for Density of Soil and Soil-Aggregate in Place by Nuclear Methods).
2. Compaction tests shall be performed at a depth of one-and-one-half feet (1-1/2') above the top of the pipe and in one-foot (1') vertical increments up to the finish grade.
3. Compaction tests shall be performed at least once every one hundred (100) linear feet as measured along the length of the pipe.
4. If the Public Works Director/City Engineer determines that reliable and uniform results are produced by the contractor's construction techniques, the frequency of testing may be changed to one every three hundred feet (200').

(B) Compaction shall be to the following minimum densities (reference ASTM D 698 or AASHTO T 99 unless otherwise indicated):

1. Barrier Material - 95 Percent of Maximum Standard Density.
2. Pipe Bedding:
  - a. Compacted Granular Material - 80 Percent of Maximum Relative Density (ASTM D 2049).
  - b. Carefully Compacted Select Soil - 95 Percent of Maximum Standard Density
  - c. Barrier Material - 95 Percent of Maximum Standard Density
3. Trench Backfill:
  - a. Paved roadways, sidewalks, and other areas - 95 Percent of Maximum Standard Density
  - b. Gravel Roadways - 95 Percent of Maximum Standard Density
  - c. Fields and All Other Areas - 90 Percent of Maximum Standard Density
  - d. Under Footings, Foundations, Structures, 100 Percent of Maximum Standard Density or in Conformance with the Approved Soils Report and Recommendations

(C) Moisture Content:

1. All compacted backfill shall be within two percent (2%) (plus or minus) of the optimum moisture content of the soil as determined by ASTM D 698.
2. Water shall be added to the material or the material shall be harrowed, disced, bladed, or otherwise worked to insure a uniform moisture content, as specified.

**9.16.0**

**EXCAVATIONS AND REMOVAL WITHIN EXISTING PAVED SURFACES**

- (A) Sawcutting of the existing pavement is required prior to final patching.
- (B) Minimum patching depths are as follows;

|                     |               |
|---------------------|---------------|
| ARTERIAL STREETS –  | 9” FULL DEPTH |
| COLLECTOR STREETS - | 7” FULL DEPTH |
| LOCAL STREETS -     | 5” FULL DEPTH |

In the event existing asphalt thickness exceeds these minimums, the patch depth shall match existing.

- (C) **ALL TRENCH BACKFILLING SHALL BE ACCOMPLISHED BY USING FLOW-FILL/FLOWABLE FLYASH MATERIAL CONFORMING TO SECTION 9.24.00 OF THESE SPECIFICATIONS.**
- (D) No dimension of existing pavement less than 3 feet shall be left between the new patch and existing lip of gutter (5 feet for concrete). On Arterial or Collector streets, no side of a patch shall fall within 2 feet of the existing wheel path. Patches within 2 feet shall require the removal of additional pavement to meet this requirement.
- (E) All patches will be 4 sided.
- (F) ALL PATCHES WILL REQUIRE THE REMOVAL AND REPLACEMENT OF AN ADDITIONAL 2 FEET OF ASPHALT ON EACH SIDE OF THE TRENCH TO COMPENSATE FOR THE VERTICAL SHEAR OF THE TRENCH WALLS. (See detail TCB1 of 1)
- (G) Patches shall not be less than 4 feet in any direction unless previously approved.
- (H) Patches in concrete pavement shall be from construction joint to construction joint.
- (I) All existing traffic control devices, including traffic marking paint, thermoplastic markings, and traffic signal loop detectors shall be replaced prior to acceptance of the patching.



- (J) Excavations that result in a patch that exceeds 8 feet in each direction shall require the use of a spreader box. Patches exceeding 12 feet in width and 200 feet in length shall require the use of a self- propelled paver.
- (K) Patches in existing paved areas shall be warranted for a period of 1 year from the date of acceptance.
- (L) Final surface tolerances shall not exceed ½ inch as measured with a 10-foot straight edge.

**9.20.00**      **MATERIAL SPECIFICATIONS**

**9.21.00**      **STABILIZATION MATERIAL**

- (A) If the existing soil in the trench bottom is judged to be unsuitable by the City Engineer, the top six inches (6") of the pipe subgrade shall be removed and replaced with a stabilization material.

Stabilization material shall conform to ASTM D 448 or CDOT No. 4, according to Table 9.21.00:

TABLE 9.21.00  
Stabilization Material

| <u>Size</u> | <u>Percent Passing</u> |
|-------------|------------------------|
| 2 Inch      | 100                    |
| 1-1/2 Inch  | 90-100                 |
| 1 Inch      | 20-55                  |
| 3/4 Inch    | 0-15                   |
| 3/8 Inch    | 0-5                    |

- (B) Geotextiles used for erosion control, drainage and silt fence shall conform to CDOT requirements of 712.08 in the Standard Specifications for Road and Bridge Construction.

**9.22.00**      **BEDDING MATERIALS**

- (A) Granular Material. Uniformly-graded material conforming to AASHTO M6, according to Table 9.22.00:

TABLE 9.22.00  
Bedding Material

| <u>Size</u> | <u>Percent Passing</u> |
|-------------|------------------------|
| 3/8 Inch    | 100                    |
| No. 4       | 95-100                 |
| No. 16      | 45-80                  |
| No. 50      | 10- 30                 |
| No. 100     | 2-10                   |

- (B) Select Soil. Excavated material which is free from rocks, clods, and stones greater than one-and-one-half inches (1-1/2") in any dimension and which meets other requirements of trench backfill material.
- (C) Barrier Material -- Soil Classification:
  - 1. GC -- Clayey gravel, gravel-sand-clay mixtures.
  - 2. SC -- Clayey sands, sand-clay mixtures.
  - 3. CL -- Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, clean clays.
  - 4. Material may be finely divided, suitable, job-excavated material free from stones, organic matter, and debris.

**9.23.00 TRENCH BACKFILL MATERIAL**

- (A) Trench backfill material shall be placed from a point twelve inches (12") above the pipe to twelve inches (12") below the ground surface or to the bottom of the pavement subgrade, whichever is greater.
- (B) Trench backfill material shall be either soil excavated from the trench or imported soil.
  - 1. Any soil used for trench backfill shall be free from frozen matter, stumps, roots, brush, other organic matter, cinders or other corrosive material, hazardous material, debris, and any rocks or stones which are larger than six inches (6") in any dimension. Rocks or stones which are larger than three inches (3") in any dimension shall not be placed within one foot (1') of pavement subgrade or within one foot (1') of the finished surface of unpaved areas or within one foot of the pipe.
  - 2. If imported soil is used for trench backfill it shall meet CDOT specifications for Class 2 structure backfill.

**9.24.00 FLOW-FILL/FLOWABLE FLY ASH BACKFILL**

**9.24.01 General**

When required or approved by the Public Works Director/City Engineer, and at the expense of the contract/developer, the following materials may be used in lieu of structure backfill (Class 1 and Class 2) or to backfill culvert pipes, storm sewer pipes, and utility cuts.

TABLE 9.24.00

**FLOW-FILL**

| <u>Ingredients</u>                     | <u>Pounds Per Cubic Yard</u> |
|--|------------------------------|
| Cement                                 | 50                           |
| Coarse Aggregate (AASHTO No. 57 or 67) | 1700                         |

|                                  |  |
|----------------------------------|--|
| Fine Aggregate Water (AASHTO M6) | 1845                                     |
| Water (39 Gallons)               | 325(or as needed for proper consistency) |

**FLOWABLE FLY ASH BACKFILL**

| <u>Ingredients</u> | <u>Pounds Per Cubic Yard</u>              |
|--------------------|---|
| Class C Fly Ash    | 200-400                                   |
| Class F Fly Ash    | 1,600-1,800                               |
| Water (96 Gallons) | 800 (or as needed for proper consistency) |

No flowable fly ash backfill will be used to backfill abutments.

**9.24.02 Compaction**

Compaction of flowable fly ash backfill will not be required if material meeting the above requirements is used.

The maximum layer thickness for flowable fly ash backfill shall be three feet. Additional layers shall not be placed until the flowable fly ash backfill has lost sufficient moisture to be walked on without indenting more than two inches. Damage resulting from placing flowable fly ash backfill in layers that are too thick or from not allowing sufficient time between placement of layers shall be removed and replaced.