

SECTION 31 23 23.16 – TRENCH BACKFILL

PART 1 - GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI): 253.1, Safety Color Code.
2. American Public Works Association (APWA): Uniform Color Code for Temporary Marking of Underground Utility Locations.
3. American Society for Testing and Materials (ASTM):
 - a. ASTM D448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
 - b. ASTM C94, Specification for Ready-Mixed Concrete.
 - c. ASTM C117, Standard Test Method for Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
 - d. ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - e. ASTM C150, Standard Specification for Portland Cement.
 - f. ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - g. ASTM D422, Standard Test Method for Particle-Size Analysis of Soils.
 - h. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/cubic ft).
 - i. ASTM D1140, Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve.
 - j. ASTM D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf).
 - k. ASTM D3776, Standard Test Methods for Mass per Unit Area (Weight) of Fabric.
 - l. ASTM D3786, Standard Test Method for Bursting Strength of Textile Fabrics: Diaphragm Bursting Strength Tester Method.
 - m. ASTM D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - n. ASTM D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - o. ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - p. ASTM D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - q. ASTM D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
 - r. ASTM D4991, Standard Test Method for Leakage Testing of Empty Rigid Containers by Vacuum Method.
 - s. ASTM D5034, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

1.2 DEFINITIONS

- A. Base Rock: Granular material upon which manhole bases and other structures are placed.
- B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.
- C. Imported Material: Material obtained by the Contractor from source(s) offsite.

- D. Lift: Loose (uncompacted) layer of material.
- E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.
- F. Prepared Trench Bottom: Graded trench bottom after stabilization and installation of bedding material.
- G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Engineer.
- H. Relative Density: As defined by ASTM D4253 and ASTM D4254.
- I. Selected Backfill Material: Material available that the Engineer determines to be suitable for a specific use.
- J. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-Graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.3 SUBMITTALS

- A. Shop Drawings: Manufacturer's descriptive literature for marking tapes.

- B. Samples:

1. Trench stabilization material.
2. Bedding and pipe zone material.
3. Granular drain.
4. Granular backfill.
5. Earth backfill.
6. Sand(s).
7. Geotextile.

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- C. Quality Control Submittals: Catalog and manufacturer's data sheets for compaction equipment.
- D. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to site.
- E. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 - PRODUCTS

2.1 MARKING TAPE

- A. Plastic:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 4 mils.
3. Width: 12 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
 - a. Reef Industries; Terra Tape.
 - b. Allen; Markline.

B. Metallic:

1. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
2. Thickness: Minimum 5 mils.
3. Width: 12 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Joining Clips: Tin or nickel-coated, furnished by tape manufacturer.
6. Manufacturers and Products:
 - a. Reef Industries; Terra Tape Sentry Line.
 - b. Allen; Detectatape.

C. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

Color ^a	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Water, irrigation, and slurry lines
^a As specified in ANSI Z53.1, Safety Color Code.	

2.2 TRENCH STABILIZATION MATERIAL

- A. Clean, hard, durable 3-inch minus crushed rock gravel, or pit run, free from clay balls, other organic materials, or debris.
- B. Uniformly graded from coarse to fine, less than 8 percent by weight passing the 1/4-inch sieve.

2.3 BEDDING MATERIAL AND PIPE ZONE MATERIAL

- A. Unfrozen, friable, and no clay balls, roots, or other organic material.
- B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.

1. Duct Banks: 3/4-inch maximum particle size.
2. PVC Irrigation System Piping, and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
3. Pipe Under 18 Inches Diameter: 3/4-inch maximum particle size, except 1/4-inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3 inches diameter.
4. Pipe Greater than 18 Inches Diameter: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe. 3/4-inch maximum particle size for PVC, FRP, or HDPE Pipe.
5. Perforated Pipe: Granular drain material.
6. Conduit and Direct-Buried Cable:
 - a. Sand, clean or clean to silty, less than 12 percent passing the No. 200 sieve.
 - b. Individual Particles: Free of sharp edges.
 - c. Maximum Size Particle: Pass a No. 4 sieve.
 - d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.4 EARTH FILL

- A. As specified in section 31 23 23.19 TRENCH BEDDING AND BACKFILL FOR WATER AND SEWER LINES.

2.5 CONTROLLED LOW STRENGTH FILL

- A. Select and proportion ingredients to obtain compressive strength between 50 and 150 psi at 28 days in accordance with ASTM D4832.
- B. Materials:
 1. Cement: ASTM C150, Type I or II.
 2. Aggregate: ASTM C33, Size 7.
 3. Fly Ash (if used): ASTM C618, Class C.
 4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.6 CONCRETE BACKFILL

- A. Provide as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.7 TOPSOIL

- A. Topsoil removed and stockpiled from onsite excavation.

2.8 SOURCE QUALITY CONTROL

- A. Perform gradation analysis in accordance with ASTM C136 for:
 1. Earth backfill, including specified class(es).
 2. Trench stabilization material.
 3. Bedding and pipe zone material.
- B. Certify Laboratory Performance of Mix Designs:
 1. Controlled low strength fill.
 2. Concrete.

PART 3 - EXECUTION

3.1 TRENCH PREPARATION

- A. Water Control: Conform to Section 31 23 19, DEWATERING.
 - 1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
 - 2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
 - 3. Provide continuous water control until trench backfill is complete.
- B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.2 TRENCH BOTTOM

- A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.
- B. Soft Subgrade: If it is encountered that it may require removal to prevent pipe settlement, notify Engineer. Engineer will determine the depth of overexcavation, if any, required.

3.3 TRENCH STABILIZATION MATERIAL INSTALLATION

- A. Rebuild trench bottom with trench stabilization material.
- B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.
- C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.4 BEDDING

- A. Furnish imported bedding material where, in the opinion of the Engineer, excavated material unsuitable for bedding or insufficient in quantity.
- B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.
- C. Hand grade and compact each lift to provide a firm, unyielding surface.
- D. Minimum Thickness:
 - 1. Pipe, 15-inch and Smaller: 4 inches.
 - 2. Pipe, 18-inch to 36 inch: 6 inches.
 - 3. Pipe, 42-inch and Larger: 12 inches.
 - 4. Conduit: 3 inches.
 - 5. Direct-Buried Cable: 3 inches.
 - 6. Duct Banks: 3 inches.

- E. Check grade and correct irregularities in bedding material. Loosen top 1 to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.
- F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.
- G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.5 BACKFILL PIPE ZONE

- A. Upper limit of pipe zone shall not be less than following:
 - 1. Pipe: 12 inches above top of pipe, unless shown otherwise.
 - 2. Conduit: 3 inches above top of conduit, unless shown otherwise.
 - 3. Direct-Buried Cable: 3 inches above top of cable, unless shown otherwise.
 - 4. Duct Bank: 3 inches above top of duct bank, unless shown otherwise.
- B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.
- C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.
 - 1. Pipes 10 Inches and Smaller Diameter: First lift less than or equal to pipe-diameter.
 - 2. Pipes Over 10 Inches Diameter: Maximum 6-inch lifts.
- D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.
- E. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.
- F. Do not use power-driven impact compactors to compact pipe zone material.

3.6 MARKING TAPE INSTALLATION

- A. Continuously install marking tape along centerline of all buried piping, at depth of 2 feet. Coordinate with piping installation drawings.
 - 1. Metallic Marking Tape: Install with nonmetallic piping
 - 2. Plastic Marking Tape: Install with metallic piping.

3.7 BACKFILL ABOVE PIPE ZONE

- A. General:
 - 1. Process excavated material to meet specified gradation requirements.
 - 2. Adjust moisture content as necessary to obtain specified compaction.

3. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.

B. Select Excavated Backfill:

1. Place in lifts not exceeding 9-inch thickness.
2. Mechanically compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

C. Excavated Backfill: Backfill trench above the pipe zone with granular backfill in lifts not exceeding 8 inches. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

D. Concrete Backfill:

1. Place above bedding.
2. Minimum Concrete Thickness: 6 inches on top and sides of pipe.
3. Do not allow dirt or foreign material to become mixed with concrete during placement.
4. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in trench.
5. Prevent flotation of pipe.
6. Begin and end concrete backfill within 4 inches of a pipe joint on each end.
7. Do not encase pipe joints except within the limits of the concrete backfill.

E. Controlled Low Strength Fill:

1. Discharge from truck mounted drum type mixer into trench.
2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.

3.8 REPLACEMENT OF TOPSOIL

- A. Replace topsoil in top 6 inches of backfilled trench.
- B. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.9 MAINTENANCE OF TRENCH BACKFILL

- A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.
- B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface, and grade and compact as necessary to keep the surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

- C. Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.
- D. Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

- A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill, will be considered a result of defective compaction of trench backfill.

- END OF SECTION -