# SECTION 312316 TRENCHING, BACKFILLING, AND COMPACTING

## PART 1 - GENERAL

A. Description

This section includes materials, testing, and installation for pipeline trench excavation, backfilling, and compacting.

B. Related Work Specified Elsewhere

1. Existing Conditions: General Conditions.
2. Supplement to General Conditions: 007300.
3. Mitigation Monitoring Compliance and Reporting: 011160.
4. Protecting Existing Underground Utilities: 020120.
5. General Concrete Construction: 030500.
6. Clearing, Stripping, and Grubbing: 311100.
7. Gravel and Crushed Rock Base for Structures: 312323.
8. Asphalt Concrete Paving: 321216.
9. Pressure Testing of Piping: 400515.

C. Submittals

1. Submit six copies of a report from a testing laboratory verifying that material contains less than 1% asbestos by weight or volume and conforms to the specified gradations or characteristics for pea gravel, granular material, imported sand, rock refill for foundation stabilization, and water.
2. Submit method(s) of compaction including removal sequence of shoring where used.

D. Testing for Compaction

1. The Owner will test for compaction as described below.
2. Determine the density of soil in place by the sand cone method, ASTM D1556 or by nuclear methods, ASTM D6938. Compaction tests will be performed for each lift or layer.

3. Determine laboratory moisture-density relations of soils by ASTM D1557. If nuclear methods are used for in-place density determination, the compaction test results for maximum dry density and optimum water content shall be adjusted in accordance with ASTM D4718. This will be required for determination of percent relative compaction and moisture variation from optimum.

4. Determine the relative density of cohesionless soils by ASTM D4253 and D4254.

5. Sample backfill materials per ASTM D75.

6. "Relative compaction" is the ratio, expressed as a percentage, of the inplace dry density to the laboratory maximum dry density.

7. Compaction shall be deemed to comply with the specifications when no more than one test of any six consecutive tests falls below the specified relative compaction. The one test shall be no more than three percentage points below the specified compaction. The Contractor shall pay the costs for any retesting or additional testing of work not conforming to the specifications.

8. Where compaction tests indicate a failure to meet the specified compaction, the Owner will take additional tests in each direction until the extent of the failing area is identified. Rework the entire failed area until the specified compaction has been achieved.

E. Pavement Zone

The pavement zone includes the asphalt concrete and aggregate base pavement section placed over the trench backfill.

F. Street Zone

The street zone is the top 36 inches of the trench immediately below the pavement zone in paved areas. Where the depth of cover over the pipe does not permit the full specified thickness of the street zone, construct a thinner street zone, extending from the top of the pipe zone to the bottom of the pavement zone.

G. Trench Zone

The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the street zone in paved areas or to the existing surface in unpaved areas. If the resulting trench zone is less than 24 inches thick, the street zone shall extend to the top of the pipe zone and there shall be no separate trench zone.

H. Pipe Zone

The pipe zone shall include the full width of trench from the bottom of the pipe or conduit to a horizontal level above the top of the pipe, as specified below. Where multiple pipes or conduits are placed in the same trench, the pipe zone shall extend from the bottom of the lowest pipe to a horizontal level above the top of the highest or topmost pipe. Thickness of pipe zone above the highest top of pipe shall be 12 inches unless otherwise shown in the drawings or otherwise described in the specifications for the particular type of pipe installed.

I. Pipe Base or Bedding

The pipe base or bedding shall be defined as a layer of material immediately below the bottom of the pipe or conduit and extending over the full trench width in which the pipe is bedded. Thickness of pipe base shall be as follows unless otherwise shown in the drawings or otherwise described in the specifications for the particular type of pipe installed.

| Pipe Diameter | Thickness of Pipe Base |
|---|---|
| 4 inches through 16 inches | 4 inches |
| 18 inches and larger | 6 inches |

PART 2 - MATERIALS

A. Granular Material for Backfill--Street and Trench Zones

Granular material or granular soil for backfill used above the pipe zone shall be lean bank-run or pit-run gravel, or native soil. The maximum particle size shall be 3 inches. A minimum of 75% shall pass the No. 4 sieve. Trench fill within 12 inches of base or pavement shall have an R-value equal to or greater than 40.

B. Native Earth Backfill--Street and Trench Zones

1. Native earth backfill used above the pipe zone shall be excavated materials free from roots, debris, rocks larger than 3 inches, asbestos, organic matter, clods, clay balls, broken pavement, and other deleterious materials. At least 75% shall pass a No. 4 sieve, and/or comply with the applicable requirements for the area where the backfill is being placed. The coarser materials shall be well distributed throughout the finer material.

2. Backfill materials that are obtained from trench excavated materials to the extent such material is available shall be screened outside of the trench prior to placement in the trench. The material shall be maintained free of unscreened material during the handling and backfilling process. Hand selecting of rocks from earth as it is placed into the trench will not be permitted in lieu of the specified screening. Under no circumstances will

native earth backfill be allowed or used in the pipe base or pipe zone areas. Backfill shall be moisture conditioned to within approximately 2% of the optimum moisture content prior to being placed in trench.

C. Imported Sand--Pipe Zone and Pipe Base

1. Imported sand used in the pipe zone or for the pipe base shall conform with Caltrans Standard Specification Section 19-3.02B and have the following gradation:

| **Sieve Size** | **Percent Passing By Weight** |
|---|---|
| No. 4 | 90 to 100 |
| No. 200 | 0 to 5 |

2. Imported sand shall have a minimum sand equivalent of 30 per ASTM D2419.

D. Gravel and Crushed Rock-- Pipe Zone, Pipe Base, and Rock Refill for Foundation Stabilization

Gravel or crushed rock material shall contain less than 1% asbestos by weight or volume and conform to the ASTM C-33 size No. 57 and shall meet the following gradation:

| Sieve Sizes | Percent Passing |
|---|---|
| 1 ½ inches | 100 |
| 1 inch | 95 to 100 |
| ½ inch | 25 to 60 |
| No. 4 | 0 to 10 |
| No. 8 | 0 to 5 |

E. Sand-Cement Slurry Backfill--Pipe Zone

Sand-cement slurry backfill shall consist of two sack (188 pounds) of Type I or II portland cement added per cubic yard of imported sand and sufficient water for workability.

F. Concrete for Pipe Encasement and Thrust Blocks

1. Concrete for unreinforced pipe encasement and thrust blocks shall be Class C per Section 030500, unless otherwise shown in the drawings.

2. Provide thrust blocks at fittings in pipe having rubber gasket bell-and-spigot or unrestrained mechanical joints. Do not provide thrust blocks for steel pipe

having welded, flanged, or butt-strap joints unless detailed in the drawings or required in the detailed piping specification.

3. See the details in the drawings for thrust block sizes. Install thrust blocks based on the test pressures given in Section 400515. Size thrust blocks in accordance with the following table:

| Pipe Test Pressure (psi) | Use Thrust Block Sizing for |
|---|---|
| 0 to 25 | 25 psi |
| 26 to 50 | 50 psi |
| 51 to 100 | 100 psi |
| 101 to 150 | 150 psi |
| 151 to 200 | 200 psi |

G. Underground Plastic Warning Tape for Pipe

Provide permanent, bright-colored, continuous-printed plastic tape, intended for direct burial service, not less than 6 inches wide by 3.5 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe. Provide the following colored tape for the various piping services:

| Service | Color |
|---|---|
| Sewer | Green |
| Water | Blue |

H. Filter Fabric

1. The filter fabric shall be polypropylene, needle-punched, non-woven geotextile, Mirafi S600, Geotex NW-601, or equal, meeting the minimum requirements of Caltrans Standard Specification Section 88-1.03.

2. Storage and Handling: Protect the fabric from direct sunlight, ultraviolet rays, and temperatures greater than 140 ˚F, mud, dirt, dust, and debris at all times during shipment and storage. To the extent possible, wrap the fabric in heavy-duty protective covering. Store the fabric on clean, dry surfaces. When stored in outside areas, keep fabric 1-foot minimum above ground level. Keep the fabric in its protective covering until ready for installation. Cover opened rolls by waterproof cover. Do not use hooks, tongs, or other sharp tools or instruments when handling fabric.

PART 3 - EXECUTION

A. Sloping, Sheeting, Shoring, and Bracing of Trenches

Trenches shall have sloping, sheeting, shoring, and bracing conforming with 29CFR1926, Subpart P--Excavations, CAL/OSHA requirements, and the General Conditions.

B. Sidewalk, Pavement, and Curb Removal

Cut bituminous and concrete pavements regardless of the thickness and curbs and sidewalks prior to excavation of the trenches with a pavement saw or pavement cutter. Width of the pavement cut shall be at least equal to the required width of the trench at ground surface. See drawings for pavement removal and repair details. Haul pavement and concrete materials from the site. Do not use for trench backfill.

C. Trench Excavation

1. Excavate the trench to the lines and grades shown in the drawings with allowance for pipe thickness, sheeting and shoring if used, and for pipe base or special bedding. If the trench is excavated below the required grade, refill any part of the trench excavated below the grade at no additional cost to the Owner with foundation stabilization material encased in filter fabric as described in Part 3, paragraph H of this Specification. Place the refilling material over the full width of trench in compacted layers not exceeding 8 inches deep to the established grade with allowance for the pipe base or special bedding.

2. Trench widths in the pipe zone shall be as shown in the drawings. If no details are shown, maximum width shall be 24 inches greater than the pipe outside diameter. Comply with 29CFR Part 1926 Subpart P--Excavations. Trench width at the top of the trench shall be the minimum reasonably required to perform the work. Limit the width of excavation where the width would undercut adjacent structures and footings. In such case, width of trench shall be such that the structure is behind a 1:1 line projected upward from the nearest bottom edge of a shored trench excavation, or the building is setback at least 10 feet horizontally from a properly sloped excavation.

3. Contractor is responsible for design of temporary slopes and/or shoring in accordance with 29CFR Part 1926 Subpart P—Excavations, CAL/OSHA requirements for Type C soils. Dragging of shields will not be permitted unless provisions exist to emplace the shield tight against the sidewalls.

D. Trench Excavation in Backfill and Embankment Areas

1. Construct and compact the embankment to an elevation of 1 foot minimum over the top of the largest pipe or conduit to be installed.

2. Excavate trench in the compacted backfill or embankment.

E. Location of Excavated Material

1. During trench excavation, place the excavated material only within the working area. Do not obstruct any roadways or streets. Do not place trench spoil over pipe, buried utilities, manholes, or vaults. Conform to federal, state, and local codes governing the safe loading of trenches with excavated material.

2. Remove and store excavated topsoil separately. Refer to Section 011600 for mitigation measures.

3. Stockpile excavated material at a distance away from excavation greater than a 1:1 line projected upward from the bottom edge of the trench or excavation.

4. Do not operate cranes and other equipment on the same side of the trench as the spoil piles.

F. Length of Open Trench

Limit the length of open trench to 300 feet in advance of pipelaying or amount of pipe installed in one working day. Complete backfilling and temporary paving not more than 1,000 feet in the rear of pipelaying, see Section 015526 and 321216 paving requirements.

G. Dewatering

1. Comply with NPDES requirements as necessary

2. Obtain approval for disposal location from Owner's Representative before disposing of water.

3. Provide and maintain means and devices to remove and dispose of water entering the trench excavation during the time the trench is being prepared for the pipelaying, during the laying of the pipe, and until the backfill at the pipe zone has been completed. These provisions shall apply during both working and nonworking hours, including lunch time, evenings, weekends, and holidays. Dispose of the water in a manner to prevent damage to adjacent property and in accordance with regulatory agency requirements. Do not drain trench water through the pipeline under construction.

H. Foundation Stabilization

1. After the required excavation has been completed, the Owner's Representative will inspect the exposed subgrade to determine the need for any additional excavation. It is the intent that additional excavation be

conducted in all areas within the influence of the pipeline where unacceptable materials exist at the exposed subgrade. Overexcavation shall include the removal of all such unacceptable material that exist directly beneath the pipeline to a width 24 inches greater than the pipe outside diameter and to the depth required by the Owner's Representative, with a minimum of 12 inches.

2. Place filter fabric on the bottom of the trench and up the sides a sufficient height to fully wrap the rock refill material, and achieve a 12-inch overlap. Protect fabric during installation from clogging, tears, and other damage. Install in accordance with manufacturer's recommendations. Place fabric with the long dimension parallel to the trench and lay smooth. Stretch and align the fabric in a wrinkle-free manner. Place the strips to provide a minimum width of 12-inches overlap at each joint. Provide ballast (e.g., sand bags) to prevent uplift from wind. Do not leave fabric uncovered for more than 7 days after installation.

3. Do not cover filter fabric prior to inspection by the Owner's Representative. Protect the filter fabric from damage due to the placement of rock refill by limiting the height of drop of the material to less than 3 feet. Backfill the trench to subgrade of pipe base with rock refill material for foundation stabilization. Place the foundation stabilization material over the full width of the trench and compact in layers not exceeding 8 inches deep to the required grade. Completely wrap rock/gravel with filter fabric, ensuring a minimum overlap of 12-inches.

4. Rock refill used by the Contractor for his convenience will not be cause for any additional payment.

I. Installing Buried Piping

1. Grade the bottom of the trench to the line and grade to which the pipe is to be laid, with allowance for pipe thickness. Remove hard spots that would prevent a uniform thickness of bedding. Place the specified thickness of pipe base material over the full width of trench. Grade the top of the pipe base ahead of the pipelaying to provide firm, continuous, uniform support along the full length of pipe, and compact to the relative compaction specified herein. Before laying each section of the pipe, check the grade and correct any irregularities.

2. Excavate bell holes at each joint to permit proper assembly and inspection of the entire joint. Fill the area excavated for the joints with the bedding material specified or indicated in the drawings for use in the pipe zone.

3. Inspect each pipe and fitting before lowering the buried pipe or fitting into the trench. Inspect the interior and exterior protective coatings. Patch damaged areas in the field with material recommended by the protective coating

manufacturer. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after installation.

4. Handle pipe in such a manner as to avoid damage to the pipe. Do not drop or dump pipe into trenches under any circumstances.

5. When installing pipe, do not deviate more than 0.25-foot from line or 0.15-foot from grade. Measure elevation at the top of pipe barrel.

6. After pipe has been bedded, place pipe zone material simultaneously on both sides of the pipe, in maximum 8-inch lifts, keeping the level of backfill the same on each side. Carefully place the material around the pipe so that the pipe barrel is completely supported and no voids or uncompacted areas are left beneath the pipe. Use particular care in placing material on the underside of the pipe to prevent lateral movement during subsequent backfilling.

7. Compact each lift to the relative compaction specified herein.

8. Push the backfill material carefully onto the backfill previously placed in the pipe zone. Do not permit free-fall of the material until at least 2 feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe. Do not operate heavy equipment or a sheepsfoot wheel mounted on a backhoe over the pipe until at least 3 feet or one-half of the internal diameter, whichever is greater, of backfill has been placed and compacted over the pipe.

9. During backfilling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 12 inches above the top of the pipe. Where multiple small lines are buried in common trench and do not exceed overall width of 16 inches, install single line marker. For the deep trench section install an additional warning tape at 8-ft below ground surface.

10. When the pipelaying is not in progress, including the noon hours, close the open ends of pipe. Do not allow trench water, animals, or foreign material to enter the pipe.

11. Keep the trench dry until the pipelaying and jointing are completed.

J. <u>Backfill Compaction</u>

1. Unless otherwise shown in the drawings or otherwise described in the specifications for the particular type of pipe installed, relative compaction in pipe trenches shall be as follows:

   a. Pipe Zone: 90% relative compaction.

b. Backfill in Trench Zone Not Beneath Paving: 90% relative compaction. Compact backfill within embankment above the pipe zone to the same relative compaction as the adjacent embankment.

c. Backfill in Trench Zone to Street Zone in Paved Areas: 95% relative compaction.

d. Backfill in Street Zone in Paved Areas: 95% relative compaction.

2. Compact rock refill for foundation stabilization with four (4) full passes with a vibratory compactor per lift.

3. Compact trench backfill to the specified relative compaction. Compact by using mechanical compaction, or hand tamping. Do not use high-impact hammer-type equipment except where the pipe manufacturer warrants in writing that such use will not damage the pipe. Do not use jetting or ponding of water to assist with compaction.

4. Compact material placed within 12 inches of the outer surface of the pipe by hand tamping only.

5. Do not use any axle-driven or tractor-drawn compaction equipment within 5 feet of building walls, foundations, and other structures.

K. Material Replacement

Remove and replace any trenching and backfilling material that does not meet the specifications, at the Contractor's expense.

L. Placing Sand-Cement Slurry Backfill

Place sand-cement slurry backfill in a uniform manner that will prevent voids in or segregation of the material. Remove foreign material that falls into the excavation or trench. Do not commence backfilling over or place any material over the slurry cement backfill until at least four hours after placing the sand-cement slurry.

END OF SECTION