

SECTION 02202

TRENCHING AND BACKFILL

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. This section covers trenching and backfill requirements for buried piping systems specified in Water System - Section 02660; Storm Drainage - Section 02720; Sanitary Sewers -Section 02730; Irrigation Systems - Section 02910, Street and Safety Lighting -Section 16500.
- B. This Section also covers requirements for excavation and for compaction of succeeding layers after backfill has been placed around pipe.

1.02 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the general designation only.
- B. American Society for Testing and Materials (ASTM) Publications:
 - C - 33 Specification for Concrete Aggregates
 - C - 136 Sieve Analysis of Fine and Coarse Aggregates
 - C - 150 Portland Cement
 - C - 260 Air Entraining Admixtures
 - D - 424 Plastic Limit and Plasticity Index of Soils
 - C - 618 Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement
 - D - 1557 Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb. (4.54 KG) Rammer and 18-in. (457 mm) Drop
 - D - 2419 Sand equivalent Value of Soils and Fine Aggregate
 - D - 2487 Classification of soils for Engineering purposes
 - D - 3017 Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth)

1.03 SUBMITTALS

- A.** Certified test reports for the permeable material backfill tested in accordance with ASTM C 136.
- B.** Samples: Submit 1 gallon size sample of permeable material for approval.
- C.** Shoring and Sheet piling Plan: Before starting work submit a CAL-OSHA permit for the shoring and sheet piling plan when trench excavation is five feet deep or more.
- D.** Dewatering Plan: If required in the Special Conditions, before starting work submit a dewatering plan describing the basic components of the dewatering including silt control, etc.
- E.** Traffic Plan: When work will occur on or adjacent to the right-of-way submit a Traffic Control Plan in accordance with section 01550 72 hours in advance for approval prior to starting work.

1.04 QUALITY ASSURANCE

- A.** Percentage of compaction specified shall be the minimum acceptable. The percentage represents the ratio of the dry density of the compacted backfill material to the maximum dry density of the material as determined by the procedure set forth in ASTM Designation D1557. For field density tests, ASTM D-3017 may be used.
- B.** D-load or class of pipe requirements shown or called for on the plans shall be the minimum acceptable.

1.05 JOB CONDITIONS, PROTECTION, AND SHORING

A. Existing Utilities:

1. Unless shown to be removed, protect active utility lines shown on the Plans or otherwise made known to the Contractor prior to excavating. If damaged, repair or replace at the Contractor's expense. Pothole as required to verify utility location. Contractor shall be responsible for contacting all utility companies and coordinating any work which requires relocation or abandonment of existing utilities.
2. If active utility lines are encountered and are not shown on the Plans or otherwise made known to the Contractor, promptly take necessary steps to assure that service is not interrupted.
3. If a known service is interrupted as a result of work under this section, immediately restore service by repairing the damaged utility at Contractor's expense.
4. If foreseen or unforeseen existing utilities are newly found to interfere with the permanent facilities being constructed under this Contract, immediately notify the Engineer for directions.

5. Do not proceed with permanent repair or relocation of utilities until written instructions are received from the Engineer.
6. No construction water shall be disposed of in the City's storm drain system.
7. Comply with all conditions and requirements indicated and specified under the specific utility section of these specifications.

B. PROTECTION OF PERSONS & PROPERTY:

1. Install all necessary underpinning, shoring, lagging, cribbing, and bracing of ample strength to support adjoining soils, paving and structures. All such items shall be so constructed that they will not interfere with the building of any structural elements, and shall be removed upon completion of the shoring operation.
2. Barricade open depressions and holes occurring as part of this work, and post warning lights on property adjacent to or with public access.
3. Operate warning lights during hours from dusk to dawn each day and as otherwise required.
4. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by operations of Contractor.
5. No trenches shall be left open during non-working hours.
6. Install fences and barricades to secure the area from the public.

C. SHORING

1. The Contractor is solely responsible for all bracing and shoring. The Contractor shall forward their application for shoring to the California Division of Industrial Safety for their review. Contractor's application shall include the basic design, assumed soils conditions and estimation of forces to be resisted, together with plans and specifications of the materials and methods to be used, and shall be prepared by a Civil Engineer registered in California.
2. If an application for a shoring permit is required, no excavation in trench section or around structures shall proceed until the approved shoring plan has been received by the Engineer.

D. DEWATERING

1. Remove all water, including rain water, encountered during trench and sub-structure work to an approved location by pumps, drains, and other approved methods.
2. Keep excavations and site construction area free from water.

E. DUST CONTROL

1. Use means necessary to control dust on and near the work, and on and near off-site areas, if such dust is caused by the Contractor's operations

during performance of the Work, or if resulting from the condition in which the Contractor leaves the site.

2. Thoroughly moisten surfaces as required to prevent dust being a nuisance to the public, neighbors, and personnel performing other work on the site.
 3. Use dust palliatives or reclaimed water (not potable water).
- F. Maintain access to adjacent areas at all times.
- G. Maintain and/or replace all bench marks, monuments, construction stakes and other reference points.
- H. Repair or restore damage to any portion of the work resulting from movement of the sides or bottom of trenches or other excavation which is attributable to the Contractor's acts or omissions, whether sides are braced or not.

PART 2 - PRODUCTS

2.01 GENERAL SOIL MATERIALS

- A. In general, soils used for backfill shall be select material free of debris, roots, wood, scrap material, vegetation, refuse, soft unsound particles, frozen, deleterious, or objectionable materials, satisfactory to the Engineer, free of stones or lumps exceeding 3 inches in greatest dimension.

2.02 PIPE BEDDING AND INITIAL BACKFILL MATERIAL

- A. Pipe bedding and initial backfill up to six inches above the top of the pipe shall be Class I, Type A, $\frac{3}{4}$ " maximum size gradation permeable material, conforming to Section 68-2.02F(2) of the State of California Department of Transportation Standard Specifications.
- B. Material shall contain at least 75% of the particles having one or more fractured faces.
- C. Bedding and backfill material shall be subject to the approval of the Engineer.

2.03 SELECT BACKFILL ABOVE INITIAL BACKFILL OR BEDDING

- A. In non-paved areas unless otherwise shown on plans, select backfill shall conform to the requirements for soil materials above, and shall be classified as (GW), (GP), (GM), (SW), (SP) or (SM) by ASTM D 2487 and meet the following:
1. Sand equivalent shall not be less than 25 when tested in accordance with ASTM D 2419, plasticity index shall not exceed 15 when tested in accordance with ASTM D 424, and not more than 25% by weight shall be finer than the No. 200 sieve.
 2. On-site native material may be used as backfill if it conforms to 2.03A.1, above.

- B. In paved areas, except Bay Mud, select backfill shall be Class 2 aggregate base, 3/4" maximum size gradation conforming to Section 26-1.02B of the State of California Standard Specifications.

2.04 SPECIAL REQUIREMENTS FOR SELECT BACKFILL IN BAY MUD CONDITIONS

- A. In areas where Bay Mud is prevalent, there are two distinct types of soil material present, Bay Mud and Imported Fill Material. Bay Mud consists of very soft, cohesive, clayey material, and it may be encountered from 1 to 4 feet below grade, depending on location. (At Redwood Shores for example, Bay Mud generally occurs at elevation 100). Excavated Bay Mud may be either segregated and hauled off the site, or dried and conditioned for placement back into the trench per Paragraph 3.07 of this specifications section, at the Contractor's option.
- B. The existing imported fill may be salvaged and used for backfill if it meets with the requirements of select backfill, per Paragraph 2.03 of this specifications section.
- C. Suitable excavated Bay Mud from trenches may be conditioned by aeration and used as backfill. To accelerate drying to optimum moisture content for compaction as backfill, spreading, disking or harrowing may be required.

2.05 SUBDRAIN MATERIAL

- A. Where required for trench drainage and for subsurface drains, bedding shall conform to the requirements of Class 1, Type A Permeable material per Section 68 of State Standard Specifications.

2.06 CONTROLLED DENSITY FILL (CDF) (in trenches)

- A. Controlled density fill will be accepted in lieu of the standard backfill specifications. It shall be mandatory in trenches eight (8) inches wide or less where the prevention of subsequent settlement after placement of backfill is required. CDF shall conform to the following requirements:

1. Strength Requirements

- a. Non-structural CDF that can be excavated by hand shall produce unconfined compressive 28 day strengths from 50 psi to a maximum of 150 psi. CDF that is to be excavated by hand shall contain aggregate no larger than 3/8" top size nor shall the 3/8" aggregate comprise more than 30% of the total aggregate content.

2. Materials

- a. Cement shall meet the standards as set forth in ASTM C-150, Type II Cement.
- b. Fly ash shall meet the standards as set forth in ASTM C-618, for Class F pozzolans. The fly ash shall not inhibit the entrainment of air.

- c. Air entraining agent shall meet the standards as set forth in ASTM C-260.
 - d. Aggregates need not meet the standards as set forth in ASTM C-33. Any aggregate, producing performances characteristics of the CDF, for any project will be accepted for consideration as follows. The amount of material passing a #200 sieve shall not exceed 12% and no plastic fines shall be present.
3. Mix Proportions
- a. CDF shall be a mixture of cement, Class F pozzolan, aggregate, air entraining agent and water. CDF shall be batched by a ready mixed concrete plant and delivered to the job site by means of transit mixing trucks except for
 - b. The actual mix proportions shall be determined by the producer of the controlled density fill to meet job site conditions, minimum and maximum strengths, and unit weight. Entrained air content shall be a minimum of 4.0%. The actual entrained air content shall be established for each job with the materials and aggregates to be used to meet the placing and unit weight requirements. Entrained air content may be as high as 20% for fluidity requirements.
4. Mix Design
- a. Mix design shall meet the Engineer's approval.

PART 3 - EXECUTION

3.01 GENERAL TRENCHING AND EXCAVATING

- A.** Trenches may be excavated either by hand, or mechanically. Trenches shall be cut with vertical sides, and shall be of sufficient width to provide adequate space for working therein; such space shall be a minimum clear distance of six (6) inches of shoring and a maximum of nine (9) inches clear of shoring on each side of the pipe barrel when the pipe is properly placed and aligned in conformity with the plans. Glory hole excavation or vee trenches will not be allowed. Trench sides shall be parallel to and at equal distance from the center-line of the pipe, when aligned in conformity with the plans.
- B.** Excavated material shall be loaded into trucks immediately upon removal from the trench to prevent stockpiling on roadways or walkways.
- C.** Where the excavated trench exceeds the widths specified above, furnish higher strength pipe, or other methods of construction as approved by the Engineer, to adequately provide for the increased loading, which the trench widening will cause. Stepped trenches shall meet the approval of the Engineer.
- D.** Pipe trenches shall be excavated to a depth below the bottom of the pipe sufficient to provide for pipe bedding materials as required by Section 3.02.

- E. Where a trench has been excavated below the designed grade, the bottom of the trench shall be refilled to proper subgrade with approved material well compacted in place, in an approved manner.
- F. The Engineer shall have the right to limit the amount of trench which is opened or partially opened at any one time; and also to limit the amount of trench left without backfill, at any one time.
- G. No trench or holes shall be left open overnight. Use steel plates to protect open trenches overnight.
- H. Excavation for thrust blocks shall be neat to the line and dimensions shown or called for on the plans.
- I. Provide for dewatering trenches and excavations and subsequent control of ground water, utilizing such pumps or other equipment as may be necessary to control ground water and seepage until backfilling is completed.

3.02 GENERAL BEDDING

- A. Utilities shall be laid on a firm layer of firm bedding material not less than four (4) inches in depth as shown or as noted on the plans and detail drawings, except that bedding shall not be required for utilities two (2) inches or less in nominal diameter. Compact as specified herein.
- B. Upon completion of bedding operations and, prior to the installation of pipe or appurtenances, notify the Engineer who will then inspect the bedding layer. Pipe laying shall not commence until the bedding has been approved.

3.03 GENERAL BACKFILLING

- A. Backfill shall be as shown on the plans. Place in 6-inch maximum loose lifts to one foot above pipe unless otherwise specified. Bring up evenly on each side, and for the full length of the structure. Ensure that no damage is done to structures or protective coatings thereon. Place the remainder of the backfill in 8-inch maximum loose lifts unless otherwise specified. Compact each loose lift as specified in Paragraph 3.04 "General Compaction" before placing the next lift. Where unacceptable settlements occur in trenches and pits due to improper compaction, excavate to the depth necessary to rectify the problem, then backfill and compact the excavation as specified herein and restore the surface to the required elevation.
- B. No backfill shall be placed until the line has been inspected and approved for backfilling.

3.04 GENERAL COMPACTION

- A. Use hand-operated plate type vibratory or other suitable hand tampers in areas not accessible to larger rollers or compactors. Be careful to avoid damaging pipes and protective pipe coatings. Compaction shall be in accordance with the following unless otherwise specified. If necessary, the Contractor's selected

equipment and construction procedure shall be altered, changed or modified in order to meet the specified compaction requirements.

- B.** Initial backfill and bedding shall be carefully packed under the haunches of the pipe and brought up simultaneously on both sides so as to obviate any displacement of the pipe from its true alignment. Bedding shall be compacted in layers not more than eight (8) inches in thickness in a manner that will preclude moving the pipe, to not less than 95% of maximum dry density as determined by the procedure set forth in ASTM Designation D1557. Jetting of backfill material will not be permitted.
- C.** Select backfill above the initial backfill shall be placed in loose lifts not exceeding eight (8) inches in thickness before compaction, and compacted by the use of pneumatic tampers or other mechanical means approved. Water or dry, as required, to bring the soils as close as practicable to the optimum moisture content for proper compaction. Compaction equipment or methods that produce horizontal or vertical earth pressures which may cause excessive displacement or may damage the pipeline will not be permitted. Lifts of backfill shall be compacted to not less than 95% of maximum dry density as determined by the procedure set forth in ASTM Designation D1557. Jetting of backfill material will not be permitted.
- D.** For flowable CDF, compaction is not necessary for placement. Trench sections may be filled in one lift above the initial backfill material. Trench sections may be filled in one lift above the initial backfill material in a manner which will; not disturb the line, prevent a misalignment, movement, floatation of or otherwise damage the utility.
- E.** Backfill will be inspected and tested by the Engineer during placement. Contractor shall cooperate with the Engineer and shall provide working space for such tests in his operations. Backfill not compacted in accordance with these specifications shall be recompacted, or removed as necessary and replaced to meet specified requirements prior to proceeding with the work.

3.05 GENERAL BRACING AND SHORING

- A.** The Contractor shall furnish, place and maintain such bracing and shoring as may be required to support the sides of the excavations for the proper protection of workmen; to facilitate the work; and to prevent damage to adjacent structures or facilities.
- B.** Upon completion of the work, all bracing and shoring shall be removed, unless otherwise directed by the Engineer. Current requirements are for a maximum depth of 5 feet without CAL-OSHA approved shoring.

3.06 SPECIAL REQUIREMENTS FOR SHORING AND EXCAVATING IN BAY MUD

- A.** Trenches or other excavations, where the distance from the existing grade to the bottom of the excavation exceeds eight (8) feet, shall be interlocking, continuous solid sheathing. Said sheathing shall be designed to resist an equivalent fluid pressure having a density of at least 100-lbs.per cubic foot for the full height of

the trench and shall be installed for the full depth of trench and to a sufficient depth below the bottom of the excavation to prevent heaving of the bottom, and shall be adequately supported in place with walers and braces. Fill voids between sheathing and trench wall with pea gravel.

- B.** Mandatory use of solid sheathing at designated locations shall not relieve the Contractor of the responsibility to install sheathing at other locations required or where necessary for safety of workmen or the general public. Excavations below Bay Mud shall be accomplished between previously placed sheathing and bracing in those areas where solid sheathing is required. The required bracing and sheathing will be installed prior to excavating below braced elevation.
- C.** Material which is salvaged from the trench and stockpiled for later use as backfill, shall be stored a minimum distance of 10 feet, but no less than 3 times the trench depth from the edge of the excavation.
- D.** Sheathing shall be withdrawn only after backfill above the pipe has proceeded to a height equal to or greater than 3/4 of the excavation depth. Bottom cross bracing and walers may be left in place upon removal of the sheathing. Backfill shall be brought to the level of the cross-braces before these are removed.
- E.** Install and extract the sheathing in a manner which will not disturb the line, grade, backfill compaction or operation of the utility being installed or adjacent utilities and improvements.

3.07 SPECIAL REQUIREMENT FOR BACKFILL IN BAY MUD CONDITIONS

- A.** Bay Mud, if used as backfill at the Contractor's option, shall be spread and dried to optimum moisture content, then replaced in the trench to the same elevation below grade as the existing Bay Mud, as directed.
- B.** Imported fill material, which has been salvaged from trench excavation for use as select backfill, shall be stockpiled alongside the excavation unless otherwise directed. Material shall not be stockpiled higher than four (4) feet and shall be kept back from the trench a horizontal distance at least equal to the depth of excavation.
- C.** All material excavated within the limits of work, not required as backfill, shall then be transported and dumped or conditioned to optimum moisture content and compacted as embankment at the site noted on the plans or as directed.
- D.** On-site native Bay Mud for use as backfill shall be conditioned by means of watering or aeration as may be required to bring the material to the range of moisture content satisfactory for compaction to project specification.
- E.** Prior to placing conditioned material as backfill, the material shall be thoroughly and uniformly mixed to the satisfaction of the Engineer, and the moisture content shall be within the allowable range for compaction to project specification. Material which has dried to less than allowable moisture content shall be reconditioned to an acceptable moisture content and re-mixed to the satisfaction of the Engineer.

3.08 SPECIAL REQUIREMENT FOR COMPACTION IN BAY MUD

- A.** Compaction procedures are as described in paragraph "General Compaction" except that the density of compaction shall be 90% as determined by ASTM Designation D1557, except for the top 6" in paved areas which shall be compacted to 95%.
- B.** Remove shoring or sheathing as described above, making sure that the pipe is not displaced.

3.09 SPECIAL EARTHWORK REQUIREMENTS FOR SUBSURFACE DRAINS

- A.** Excavate to the dimensions indicated.
- B.** Provide a bedding surface of uniform density consisting of permeable material as indicated in paragraph 2.02 of this specifications section.
- C.** Backfill around and over the pipes after pipe installation has been approved with permeable material to the depth indicated. Place in maximum loose lifts of 8 inches.
- D.** Compact each lift with mechanical tampers or rammers. Compact bedding and backfill materials to 90% of ASTM D1557, Method D, maximum density. Place the remainder of the trench backfill as specified.

3.10 SPECIAL REQUIREMENTS FOR CONTROLLED DENSITY FILL (CDF)

- A.** Applications of CDF include, but are not limited to: backfills, structural fills, insulating fills, road base, slab base, trench bedding, void and abandoned tank fills caisson and pile fills, abandoned pipes and culverts.
- B.** CDF shall be discharged from the mixer by any reasonable means into the area to be filled, including tremie methods or elephant trunk chutes. CDF shall be brought uniformly to the elevation as shown on the plans. Trench sections to be filled with CDF shall be contained at either end by bulkheads of earth fill.
- C.** Permanent pavement may be placed directly upon the CDF as soon as it has sufficiently self-consolidated so that the surface will withstand the process of paving without displacement or disruption. If the placement of the CDF is not completed early enough to allow for permanent paving to be completed the same day, the contractor shall provide steel plates to span the trench and prevent traffic contact with the CDF overnight or until permanent paving can be placed.
- D.** Compaction is not necessary when placing CDF.

3.11 FIELD QUALITY CONTROL

- A.** The Engineer will inspect, test and approve trench backfill layers before further construction is permitted thereon. Number of tests required will be determined by the Engineer.

- B. If backfill has been placed, that is below the specified density, provide additional compaction with subsequent retesting until successful compaction is achieved.

3.12 DUST ALLEVIATION AND CONTROL

- A. Contractor shall be responsible for and shall provide pollution and dust abatement and control measures satisfactorily during the course of the work.
- B. The Contractor shall utilize reclaimed water, or dust palliatives, in compliance with the City's Water Conservation Ordinance.

3.13 FINISH OPERATIONS

- A. Pipes shall be laid to finished grades indicated on the plans.
- B. Dispose of all surplus material or material unsuitable for filling or grading off the site in a legal manner.
- C. Satisfactorily restore any existing improvements, paving, landscaping, and other utilities disturbed during the course of constructing the improvements.
- D. Existing traffic markings and control devices damaged or disturbed during construction shall be replaced or repaired to the satisfaction of the Engineer.

* * *