

SECTION 31 23 33

TRENCH EXCAVATION AND BACKFILL

PART 1 – GENERAL

1.01 WORK INCLUDED

- A. It is the general intent of these specifications to specify conduct of the work in such manner as to cause the general public a minimum of inconvenience, with no exposure to unsafe conditions during construction, and to provide a trench that will properly support and protect the pipe and have no settlement on improved streets and only minor settlement in other areas where such settlement will not be noticed, or compensation made for any expected settlement. The degree of compaction and type of material will vary in accordance with type of pipe and soil and surface conditions.
In general, it is the City's standard policy that no trenching will be allowed on a City Street until a period of five calendar years has expired from the previous time of trenching. In any case, when trenching occurs on a city street, the entire affected city block will be repaved in accordance with the Special Provisions and Project Plans.
- B. Excavation of all earth, regardless of character and subsurface conditions, to the required lines and grade as shown on the plans for the installation of the subsurface pipelines, utilities, conduits, etc.
- C. Shoring designed for general safety, worker protection, and protection of adjacent property from the hazards of caving ground shall be required for:
 - 1. Trench excavations
 - 2. Structural excavations
- D. Control of ground water.
- E. Backfill from the required pipe cover depth to subgrade.
- F. Compaction as shown on the plans and as specified herein.
- G. Restoration of traffic signals, conduits, detector loops and/or pavement markings damaged during construction.
- H. See Sections 33 10 00, 33 30 00, and 33 40 00 for additional specifications relating to water pipes, sewer pipes, and storm drain pipes.

1.02 RELATED REQUIREMENTS

City Standard Detail Drawing for Trenching and Backfill.

1.03 REFERENCE STANDARDS

Not used

1.04 QUALITY ASSURANCE

- A. All work under this section will be subject to the inspection and approval of both the Engineer and an approved geotechnical engineer registered in California. Compaction testing either shall be performed by the geotechnical engineer or by a City approved independent testing laboratory under the supervision of a California registered geotechnical engineer.

- B. The geotechnical engineer shall make enough visits to the site to insure ongoing familiarity with the progress and quality of the work. The geotechnical engineer shall make a sufficient number of field observations and tests to allow the forming of an opinion regarding the adequacy of the site preparation, the acceptability of the native or import fill material, and the extent to which the degree of compaction meets the specification requirements and the project needs.
- C. Any fill where the site preparation, type of material, or compaction is not approved by the geotechnical engineer, shall be removed and/or re-compacted until the requirements are satisfied and approved by said geotechnical engineer. As required, fill material shall be tested for pollutants and certified for suitability by the geotechnical engineer.
- D. On City-funded projects, services of the geotechnical engineer and/or testing laboratory shall be retained by, and paid for by the City. On all other projects, the geotechnical engineer and/or testing laboratory shall be retained by, and paid for by the developer. For City-funded projects, testing will be paid for by the City; however, testing or retesting caused by unsatisfactory contract operations shall be paid for by the Contractor.
- E. The geotechnical engineer shall provide quality assurance reports as required and accepted by the Engineer.

1.05 MEASUREMENT AND PAYMENT

Measurement and payment of trench excavation and backfill shall be included in the cost per lineal foot of the size of pipe installed or the structure constructed.

1.06 PERMIT

For trenches or excavations five feet (5') deep or deeper, the Contractor shall obtain a permit for such excavation from the State Department of Industrial Relations, Division of Safety and Health (DOSH). The Contractor shall submit a copy of the permit to the Engineer prior to initiating any work requiring said permit.

1.07 ENGINEER'S REVIEW

- A. The duty of the Engineer to conduct construction review of the Contractor's performance is not intended to include a review or approval of the adequacy of the Contractor's safety supervisor, the safety program, or any safety measures taken in, on, or near the construction site.
- B. The Engineer will review the submittal of the Contractor's proposed shoring system to verify the general scope of the work, to determine that qualified professional engineering services are used and to determine that appropriate construction techniques are proposed for use. This review shall not, in any way, be construed to relieve the Contractor from sole responsibility for the design and safety of such shoring.

1.08 GUARANTEES

- A. The Contractor shall guaranty his work against settlement for a minimum period of one (1) year after the Notice of Completion has been filed, and shall repair all damage caused by settlement within that time. For the purpose of these specifications, settlement will be deemed to have occurred if either of the following conditions exist:

1. On paved streets, a depression of three-eighths of an inch (3/8") below the average of the sides of the uncut portion; or
2. Along shoulder areas and unpaved portions of the rights-of-way, a depression of three-quarters of an inch (3/4") below the average of the sides of the uncut portion.

PART 2 – PRODUCTS

2.01 BACKFILL REQUIREMENTS – GENERAL

See the applicable City Standard Drawings for typical pipe trench requirements and indication of placement limits for pipe bedding, initial backfill and subsequent backfill. Unless otherwise specified, import materials shall not be used until suitable materials from contract excavation have been exhausted

2.02 PIPE BEDDING AND BACKFILL FOR SEWER AND STORM MAINS

Pipe bedding and backfill for Sewer and Storm mains shall be placed in accordance with City Standard Drawings **ST-06A “Trench Construction for Sewer or Storm Mains”**. Unless otherwise specified, pipe bedding and initial backfill for gravity sewer, force main, and storm mains shall be ¾” drain rock with the following gradation:

SIEVE SIZE	PERCENT PASSING
1” (25 mm)	100
¾” (19 mm)	85-100
½” (12.5 mm)	10-50
⅜” (9.5 mm)	5-20
No. 4 (4.75 mm)	<3
No. 8 (2.36 mm)	<2
No. 30 (0.60 mm)	<2
No. 100 (0.15 mm)	<2

2.03 PIPE BEDDING AND BACKFILL FOR WATER MAINS

Pipe bedding and backfill for Water mains shall be placed in accordance with City Standard Drawings **ST-06B “Trench Construction for Water Mains”**. Unless otherwise specified, pipe bedding and initial backfill for Water system ductile iron pipes shall be clean graded, imported sand with a minimum 95% dry-in-place density, as determined by ASTM D-1557. Sand shall be tested and must have a pH equal to or greater than 4.5 and less than 9, and a resistivity of less than 5,000 ohm-centimeters. The sand shall conform to the following grading when tested in accordance with ASTM C 136, “Method for Sieve Analysis of Fine and Course Aggregates”:

SIEVE SIZE	PERCENT PASSING
1/2"	100
#4	75 - 100
#50	0 - 70
#100	0 - 30
#200	0 - 15

2.04 PIPE BEDDING AND BACKFILL FOR ELECTRIC CABLE, ELECTRIC CONDUIT, AND GAS PIPE

Pipe bedding and backfill for electric cable, electric conduit, and gas pipe shall be imported sand with a minimum 95% dry-in-place density, as determined by ASTM D-1557. Backfill materials, standards, specifications, and testing shall be in accordance with **Pacific Gas and Electric Company (PG&E), Engineering Material Specification No. 4123-BACKFILL SAND dated August 30, 2012** (Copy attached as Appendix 1 to this section).

2.05 SUBSEQUENT BACKFILL

Unless otherwise specified, subsequent backfill shall consist of suitable materials obtained from contract excavation. The Contractor shall supplement with import materials, as required and authorized. Suitable materials shall be non-organic, native soil or Class 2 Aggregate Base. No fragment or rock shall be larger than 2" in the largest dimension.

2.06 OTHER BACKFILL MATERIALS

Cement slurry, drain rock and other special earth-rock backfill materials shall be provided as specified in the Special Provisions, or directed and authorized.

PART 3 – EXECUTION

3.01 GENERAL

- A. Unless otherwise indicated on the plans or in the special conditions, excavation shall be by open cut. Trenching machines may be used, except where their use will result in damage to existing facilities.
- B. Trenches shall be excavated at least six inches (6") below the barrel of the pipe and the bottom re-filled with select imported material of the type specified. See applicable City Standard Drawings, for details of trench construction.
- C. Whenever the maximum allowable trench width is exceeded for any reason, the Contractor shall concrete embed or otherwise cradle the pipe in a manner satisfactory to the Engineer.
- D. Excavation shall be supported as set forth in the rules, orders, and regulations of the California Department of Industrial Relations, Division of Industrial Accidents. All shoring, sheeting, and bracing shall conform to the requirements of the State or local agents having jurisdiction over such matters. Shoring,

sheeting, and bracing shall be removed in a manner that will protect the workers and prevent caving of banks and damage to the pipe, excavation, backfill or adjacent property. No sheeting will be withdrawn from below the top of the pipe after completion of backfill to that level.

- E. The Contractor shall do all excavation of whatever substance is encountered to the lines and grades shown on the plans. All material suitable for use as backfill shall be piled in an orderly manner at a sufficient distance from the edge of the trench to avoid overloading and to prevent sliding into the trench. The Contractor shall do such grading or work as is necessary to prevent surface water from entering the excavation. Storage of equipment or material on street right of way shall not be allowed after normal working hours.
- F. Except with specific approval of the Engineer, no more than one hundred feet (100') of open trench shall be excavated in advance of laying the pipe. Not more than twenty-five feet (25') of excavated trench shall remain un-backfilled at the end of each day's work. The remainder of the trench shall be backfilled, initially compacted, and opened to traffic. All operations shall be carried out in an orderly fashion. Backfilling, compacting and cleanup shall be accomplished as sections of the pipe are installed. Traffic through the work area shall not be impeded or obstructed at any time.
- G. Un-backfilled portions of trench shall be shored and covered each evening with steel trench plates, properly shimmed, steel spiked and ramped with temporary asphalt (cutback), and with traffic control signs and devices installed in accordance with the current edition of the State Department of Transportation "*Manual of Uniform Traffic Control Devices*".
- H. The Contractor shall obtain compaction and install base and temporary paving promptly. Contractor shall provide vehicular access to all homes each evening, install laterals promptly, all streets shall be kept clean and free of dust, mud or debris by providing daily clean up as necessary.
- I. Native material shall be used where proper compaction and a stable surface can be obtained. Stabilization methods or imported material shall be provided when and where directed by the Engineer.
- J. No backfilling shall be done until the installation to be covered has been inspected and approved for covering. Compaction of backfill shall proceed immediately after backfilling.
- K. The Contractor shall immediately notify the Engineer upon encountering underground water. Accumulated water shall be prevented from flowing down through the bedding material and later pumping out and softening of surfaces or subgrade causing pavement failure. Where water causes such problems, during either construction or the guaranty period, it shall be drained to the nearest point where flow can be acceptably relieved; using gravel encased perforated metal pipe.
- L. Sanitary sewer water shall not be allowed to flow into the storm drain system.
- M. Final paving over excavated area shall be in accordance with City Standard Drawings **ST-06A Trench Construction for Sewer and Storm Mains** and **ST-06B Trench Construction for Water Mains**.

3.02 TRENCH SAFETY PLAN

- A. For trenches and excavations five feet (5') or more in depth, the Contractor shall submit to the Engineer a detailed plan, and any revisions thereto, showing

design of shoring, bracing, sloping, or other provisions to be made for worker protection from the hazards of caving ground.

- B. Such plan shall be submitted at least ten (10) working days before the Contractor intends to begin trenching or do excavation work.
- C. If such plan varies from the shoring system standards established by the Construction Safety Orders of the Division of Industry Safety, the plan shall be prepared, sealed and signed by a Civil or Structural Engineer registered in California. Signed and sealed copies of calculations necessary to qualify the system shall also be submitted.
- D. Nothing herein shall be deemed to allow the use of shoring, sloping, or protective system less effective than that required by the Construction Safety Orders of the Division of Industrial Safety.

3.03 LAWNS AND CULTIVATED AREAS

- A. Where trench crosses lawns, the sod shall be removed by cutting, stored and kept moist and replaced to its initial condition. Where trench crosses cultivated areas, the topsoil shall be replaced and replanted or cultivated into the same condition as existed prior to excavation.
- B. Due care shall be exercised to avoid injury to existing trees, shrubs and other plants that are not to be removed. All work shall conform to **Section 31 11 00 "Clearing and Grubbing"** of the City's Technical Specifications.

3.04 WIDTH OF TRENCH

- A. Except where otherwise specifically permitted, sides of trenches shall be vertical, shored as required, and shall be of uniform width from top to bottom. Trenches shall be of a width as shown on the detail sheets in the plans, except for small diameter laterals, which may be installed in narrow "Ditch-Witch" type of trench.
- B. Unless otherwise specified or shown, the minimum width of the trench measured at the top of the pipe shall be in accordance with City Standard Drawings **ST-06A Trench Construction for Sewer and Storm Mains** and **ST-06B Trench Construction for Water Mains**.

3.05 PAVING REMOVAL

- A. Asphalt concrete shall be cut with a suitable tool, preferably a sawcutter, before excavation. Cutting with a jackhammer or a suitable grader-mounted wheel will be allowed provided that a neat orderly result is accomplished. Breaking of concrete or asphalt with excavation equipment will not be permitted.
- B. After trench backfill and compaction, existing paving shall be saw cut vertically, with a neat, square edge just prior to final paving to a point twelve inches (12") or more wider than each side of the trench line. Edges of all asphalt concrete on streets and roadways shall be saw-cut at least six inches (6") deep or to the depth of the existing asphalt concrete pavement, whichever is lesser, with a concrete saw. Saw cuts shall be parallel or perpendicular to centerline of the trench.
- C. Excess paving shall be disposed of and shall not be used as backfill material.
- D. All silt, and water used in the saw cutting operation, shall be removed through the use of a vacuum machine and properly disposed of offsite. All catch basins downstream from the saw cutting operation shall be covered to prevent sediment from entering.

3.06 SHORING, SHEETING AND BRACING

- A. The Contractor shall furnish and install all shoring, sheeting, and bracing required to support adjacent earth banks and structures for the protection and safety of all personnel working in the trench. All shoring, sheeting, and bracing shall conform to the requirements of the State Department of Industrial Relations (DIR), Division of Occupational Safety and Health (DOSH), or local agents having jurisdiction over such matters.
- B. Remove shoring, sheeting, and bracing in a manner that will protect the workers and prevent caving of banks and damage to the pipe, excavation, backfill, or adjacent property.

3.07 WATER CONTROL

- A. The Contractor shall be solely responsible for dewatering trenches and excavations, and subsequent control of ground water.
- B. Contractor shall provide and maintain such pumps or other equipment as may be necessary to control ground water and seepage, to the satisfaction of the Engineer and in compliance with the requirements of the geotechnical report. All pumped water must be treated for sediment removal prior to discharge to City storm drains. Seepage coming from the sewer line shall be disposed of into the sanitary system.

3.08 BACKFILL AND COMPACTION

- A. Initial backfill shall be carefully packed under the haunches of the pipe and brought up simultaneously on both sides, to obviate any displacement of the pipe from its true alignment. The initial backfill shall be compacted in layers no more than eight inches (8") in thickness, in a manner that will preclude moving the pipe, to not less than ninety percent (90%) of maximum dry density as determined by the procedure set forth in ASTM D 1557, *"Test Methods For Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using Ten Pound Rammer and Eighteen Inch Drop."*
- B. Water Jetting for compaction of backfill materials shall not be permitted.
- C. Subsequent backfill shall be placed in loose lifts not exceeding twelve inches (12") in thickness before compaction, and compacted by the use of pneumatic tampers or other mechanical means approved by the geotechnical engineer. Each layer shall be watered or dried, as required, to bring the soils as close as practical 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 material shall be compacted to not less than ninety percent (90%) above the pipe but not less than ninety-five percent (95%) for a minimum depth of thirty inches (30") below subgrade as determined by the procedure set forth in ASTM D 1557. Subsequent backfill for trenches in unpaved, non-traffic areas shall be compacted to not less than eighty-five percent (85%) of maximum dry density.

3.09 BASE, PAVING, AND TESTING

The Contractor shall compact material as work progresses, and base and temporary paving shall be installed the same day as excavated. Contractor shall

test pipe within five (5) working days of installation and shall install permanent paving within ten (10) working days of initial excavation.

3.10 TESTING

- A. The City shall make all tests when advised by the Contractor that, in the Contractor's opinion, sufficient densities have been achieved. If the first tests in any area fail, the Contractor shall pay for any further testing in that area until specified densities are obtained. Engineer shall determine the number and location of tests required.
- B. Contractor shall furnish a backhoe and operator upon request, at no cost to the City to assist in testing.

3.11 TRAFFIC SIGNAL FACILITIES, DETECTOR LOOPS AND PAVEMENT MARKINGS

Existing signal facilities, detector loops, and pavement markings shall be protected. Any damage shall be replaced or restored at the Contractor's expense in accordance with the specifications and as approved by the Engineer.

-END OF SECTION-

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Appendix I - Pacific Gas and Electric Company (PG&E), Engineering Material Specification No. 4123-BACKFILL SAND dated August 30, 2012



*Pacific Gas and
Electric Company.*

Gas Transmission & Distribution, Gas Engineering

BACKFILL SAND

Engineering Material Specification No. 4123

Date of Specific Issue: August 30, 2012

Supersedes Engineering Guideline 4123, Dated May 1, 1999
and Engineering Standard Specification No. 90, Dated Jan 1, 1982

Approved By: Tim Scheele, P.E., Gas Pipeline Engineer
Matteo Rossi, Gas Engineer

1.0 PURPOSE AND SCOPE

This specification covers the requirements for imported sand used in bedding and backfill in trenches for electric cable, electric conduit, and gas pipe where the minimum 95% dry-in-place density, as determined by ASTM D-1557 or equivalent, is required.

2.0 INTERPRETATION

All questions that may arise concerning interpretation of this specification or acceptability of materials furnished and delivered to PG&E under this specification must be resolved in a manner agreeable with PG&E's Gas Transmission & Distribution, Gas Engineering departments.

3.0 APPLICABLE STANDARDS

Sand shall be free of constituents that could cause adverse environmental impact. Used blasting abrasives containing toxic constituents at or above State or Federal hazardous waste levels shall not be used as backfill material. Backfill material shall consist of natural sand, manufactured sand, existing native material, or combinations thereof, and shall conform to the physical properties listed below:

3.1 Organic Impurities - ASTM C-40

Supernatant shall not be darker than Plate 3 when compared to standard Gardiner Color Series.

3.2 Sand Equivalent - ASTM D-2419

Equal to or greater than 20.

3.3 pH value - ASTM G-51-77

Equal to or greater than 4.5 and less than 9.

3.4 Resistivity R - ASTM G-57

Equal to or greater than 5,000 Ohms-cm.

If Resistivity R is *smaller* than 5,000 Ohms-cm, the following chemical contents limits shall apply:

- Total chloride content shall be equal to or less than 500 parts per million as determined by EPA Method 300.0 prepared by Parr O₂ bomb combustion.
- Total sulfate content shall be equal to or less than 150 parts per million as determined by EPA Method 300.0 prepared by Parr O₂ bomb combustion.

3.5 Compaction - ASTM D-1557

When material is compacted to a relative compaction of 95% or greater, as determined by ASTM D-1557, the material shall not slough when cross trenched.

3.0 APPLICABLE STANDARDS, continued

3.6 Gradation - ASTM C-136 & ASTM C-117

Sieve Size	Percent Passing (By Weight)
1/2"	100
No. 4	75-100 ¹
No. 50	0 - 70
No. 100	0 - 30
No. 200	0 - 15

¹ For grains retained on No. 4 sieve, the grain shape shall be rounded or sub-rounded as defined by ASTM D-2488.

3.7 Coefficient of Uniformity, $C_U \geq 2.5$

$$C_U = D_{60} / D_{10}$$

D_n = Diameter of grain size which n % of the total sample is passing

3.8 Standard Specifications

- ASTM C-40 Test for Organic Impurities in Fine Aggregates for Concrete
- ASTM D-2419 Test for Sand Equivalent Value of Soil and Fine Aggregate
- ASTM G-51-77 pH of Soil for Use in Corrosion Testing
- ASTM G-57 Soil Resistivity Field Measurement Using Wenner Four Electrode Technique
- EPA Method 300.0..Determination of Inorganic Anions in Water by Ion Chromatography
- ASTM D-1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate, Mixtures Using 10-lb. Rammer and 18-in Drop
- ASTM C-136 Sieve Analysis of Fine and Coarse Aggregate
- ASTM C-117 Test for material Finer than No. 200 Sieve by washing
- ASTM D-2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)
- ASTM D-75 Practice for Sampling Aggregate

4.0 TESTING

- 4.1 Supplier shall submit samples of Backfill Sand from each source for testing at an independent lab in accordance with all listed specifications. The lab results must be signed by a Registered Civil Engineer. Supplier shall provide certified tests reports to PG&E on request.
- 4.2 Sand sampling shall follow ASTM D-75.
 - The minimum sample size that will be accepted for testing is 100 pounds.
 - Each sample shall be representative of the material from a single source.
 - Each sample shall be marked with a unique identifier and the location where it was procured.

4.0 TESTING, continued

- 4.3 Supplier shall obtain new test results when there is a change in the original approved source.
- 4.4 PG&E reserves the right to procure samples from the source for internal testing at any time.