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.

B. 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 paving. 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.

C. 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.

D. 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

E. Control of ground water.

F. Backfill from the required pipe cover depth to subgrade.

G. Compaction as shown on the plans and as specified herein.

H. Restoration of traffic signals, conduits, detector loops and/or pavement markings damaged during construction.

I. 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

A. City Standard Detail Drawing for Trenching and Backfill.

B. Section 31 23 23.33 Controlled Low Strength Material

C. Section 33 10 00- Water Utilities

D. Section 33 30 00- Sanitary Sewer Utilities

1.03 REFERENCE STANDARDS

A. 2010 State of California Department of Transportation

Standard Specifications (SS)

Section 26 Aggregate Bases

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 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

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

A. 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, native materials shall not be used for trench backfill.

B. Crushed Rock.

1. Manufactured, angular, crushed stone with a minimum san equivalent value of 75.
2. Clean, hard, sound, durable, uniform in quality, and free of soft, liable, thin, elongated or laminated pieces, and disintegrated material.
3. Have 100 percent of its particles with at least one fractured face on a weight basis, when tested for crushed particles per ASTM D 5821.
4. Comply with the grading shown in the following table:

SIEVE SIZE	PERCENT PASSING
1” (25 mm)	100
3/4” (19 mm)	95-100
1/2” (12.5 mm)	30-60
3/8” (9.5 mm)	0-20
No. 4 (4.75 mm)	0-5
No. 8 (2.36 mm)	-

2.02 PIPE BEDDING AND BACKFILL FOR SEWER AND STORM MAINS

A. Pipe bedding and backfill for Sewer and Storm mains shall be placed in accordance with City Standard Drawing **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
3/4” (19 mm)	85-100
1/2” (12.5 mm)	10-50
3/8” (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

A. Pipe bedding and backfill for Water mains shall be placed in accordance with City Standard Drawing ST-06B “Trench Construction for Water Mains”.

B. 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.

C. Sand shall be tested and must have a pH equal to or greater than 4.5 and less than 9, and a resistivity greater than 5,000 ohm-centimeters.

D. 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
½”	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

A. 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.

B. 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

A. The Contractor shall backfill with imported Class 2 Aggregate Base materials, as required and authorized. Aggregate Materials, standards, specifications, and testing shall be in accordance with State Standard Specifications (SS) Section 26- Aggregate Bases. The grading of the material shall conform to the ¾ inch, maximum, specified in SS Section 26-1.02B, “Class 2 Aggregate Base”

B. Recycled Aggregate Base manufactured from recycled materials is acceptable provided that it meets the requirements and specifications of virgin Aggregate Base.

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. All pipe materials and accessories shall be on site prior to excavation. Unless otherwise specifically approved by the Engineer, the length of open trench shall not exceed one hundred feet (100') ahead of pipe laying, and no more than twenty-five feet (25') of excavated trench shall remain un-backfilled at end of day. Excavations in public streets shall be coordinated so as to minimize traffic interference.

C. Trenching in paved areas shall be saw cut or scored and broken ahead of trenching operations, and shall be cut or trimmed to a neat edge after backfilling. Any pavement damaged outside of the cuts shall be saw cut and restored prior to final paving.

D. 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.

E. 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.

F. 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.

G. Trenches must be kept free from water while the pipe or structures are being installed, concrete is setting, and until backfill has progressed to a sufficient height to anchor the work against possible flotation or leakage.

H. 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.

I. Shoring shall be removed only during backfill operations, and shall be done without moving the surrounding ground, piping or structure. Shoring can be left in place with the approval of the Engineer. 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"*.

J. The Contractor shall obtain compaction and install base and temporary paving promptly. Contactor 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.

K. **Native material** shall not be used for trench backfill.

L. 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.

M. 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.

N. Sanitary sewer water shall not be allowed to flow into the storm drain system.

O. 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**.

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.

3.05 ASPHALT 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 CONCRETE REMOVAL

A. Where concrete is to be removed as a part of trenching, remove concrete pavement, curb, walks access ramps and driveway in conformance with SS Subsection 15-3.3 and SS Subsection 73-1.03.

B. The Contractor shall remove and dispose of all curbs and gutter, sidewalk, and driveway approach. Limits shall be marked in the field by the Contractor and inspected by the Engineer. Limits of removal shall be along straight lines and may be along existing cold joint or expansion joint, score line, or control line or as otherwise marked by the Contractor and approved by the Engineer in the field.

C. Where the limit of removal is along a location other than an existing cold joint or expansion joint, concrete shall be neatly cut to provide a straight and uniform edge. Where necessary to meet the dimensions for new subgrade for standard curb and gutter, sidewalk, driveway or curb ramp, additional material shall be excavated and removed to provide even and uniform plane.

D. Where the plans for reconstruction of existing curb and/or sidewalk, and the limits of the new work specified do not fall on a scoring line, the entire section shall be removed and the new work shall be joined to the existing at the first scoring line beyond said specified limit.

E. The Contractor shall notify the Engineer when tree roots are exposed during concrete removal. City may inspect the tree roots to determine the limits of the root cutting or pruning. The Contractor shall perform all necessary root pruning or removal to complete the work.

3.07 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.

3.08 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.

C. Pumped water that is deemed to be contaminated shall be discharged to the sewer. City will obtain sewer discharge permit.

3.09 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.

3.10 BASE, PAVING, AND TESTING

A. 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.

3.11 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.

3.12 TRAFFIC SIGNAL FACILITIES, DETECTOR LOOPS AND PAVEMENT MARKINGS

C. 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-

- Following Page -

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