STANDARD SPECIFICATION
SECTION 02223 TRENCHING, BACKFILLING, AND COMPACTING

PART 1 - GENERAL

1.01 DESCRIPTION

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

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Standard Drawings.

B. Record Drawings and Submittals: STD SPEC 01300.

C. Clearing, Grubbing, and Stripping: STD SPEC 02110.

D. Earthwork: STD SPEC 02200.

E. Protecting Existing Underground Utilities: STD SPEC 02222.

F. Blasting: STD SPEC 02228.

G. General Concrete Construction: STD SPEC 03000.

1.03 EARTHWORK AND REPAIRS IN CITY, COUNTY, AND STATE RIGHTS OF WAY

Conform to the requirements and provisions of the permits issued by those agencies in addition to the requirements of these Standard Specifications. If a permit is not required, earthwork and repairs shall conform to the standards of the agency in whose right of way the work is done in addition to the requirements of these Standard Specifications.

1.04 SAFETY PRECAUTIONS

Observe safety precautions in all phases of the work. Included shall be trench shoring, bracing, lighting, and barricades as dictated by reason and by the Safety Orders of the Division of Industrial Safety, State of California (CAL/OSHA). Acquire an exemption letter or trenching permit from the California Division of Industrial Safety (CAL/OSHA) and comply with Labor Code Section 6705, Excavation Plans For Worker Protection. Submit a copy of the exemption letter or trenching permit with excavation drawings to the District prior to excavation work.

1.05 REGIONAL NOTIFICATION CENTER CONTACT

A. The Contractor, except in emergency, shall contact the appropriate regional notification center prior to commencing any excavation work. Notify the center at least two working days in advance or up to a maximum of 14 calendar days in advance of any excavation work. The Contractor shall delineate the proposed excavation site with white paint on paved surfacesor with marking such as flags or stakes in unpaved areas. The Contractor shall provide the regional notification center with all job site location information. The

reginal notification center will assign to the Contractor a Dig Alert Number which validatesthe Contractor’s excavation permit and will notify all of its members having subsurface installations in the area. No excavation shall be commenced and carried out by the Contractor until all existing subsurface installations have been field marked and the District has been given the Dig Alert Number by the Contractor.

B. Emergency shall be defined as a sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property, or essential public services. Emergency includes such occurrences as fire, flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage (Government Code Section 4216).

C. Subsurface installation means any underground pipeline, conduit, duct, wire, or other structure operated or maintained in or across a public street or public right-of-way (Government Code Section 4216).

1.06 OBSTRUCTIONS

The Contractor's attention is directed to the possible existence of pipe and other underground improvements which may or may not be shown on the Drawings. Preserve and protect any such improvements whether shown on the Drawings or not. Expose such improvements in advance of the pipeline construction to allow for changes in the alignment as necessary. Where it is necessary to remove and replace or to relocate such improvements in order to prosecute the work, they shall be removed, maintained, and permanently replaced by the Contractor at his expense. Protect existing underground utilities in accordance with Standard Specification Section 02222.

1.07 SUBMITTALS

A. Submit submittal packages in accordance with Standard Specification Section 01300.

B. Submit a report from a testing laboratory verifying that imported material is asbestos-free and conforms to the specified gradations or characteristics.

1.08 TESTING FOR COMPACTION

A. The District or the agency having jurisdiction over the area of the work will require the Contractor to test for compaction as described below.

B. Determine the density of soil in place by the sand cone method, ASTM D 1556, or by nuclear methods, ASTM D 2922 and D 3017.

C. Determine laboratory moisture-density relations of soils by ASTM D 1557.

D. Determine the relative density of cohesionless soils by ASTM D 4253 and D 4254.

E. Sample backfill materials by ASTM D 75.

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

G. Make excavation for compaction tests at the locations and to the depths designated by the District's Representative. Backfill and recompact the excavations at completion of testing. When tests indicate that the compaction is less than the specified relative compaction, rework and retest those areas until the specified relative compaction has been obtained.

1.09 PIPE BASE

The pipe base shall be defined as a layer of material immediately below the bottom of the pipe and extending over the full trench width in which the pipe is bedded. Thickness of pipe base shall be a minimum of 6 inches.

1.10 PIPE ZONE

The pipe zone shall include the full width of trench from the bottom of the pipe to a horizontal level 12 inches above the top of the pipe. Where multiple pipes 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 a minimum of 12 inches.

1.11 TRENCH ZONE

The trench zone includes the portion of the trench from the top of the pipe zone to the bottom of the pavement zone or to the existing surface in unpaved areas.

1.12 PAVEMENT ZONE

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

1.13 WATER FOR CONSTRUCTION

Water supplied by the District, for whatever needs and uses, shall be paid for in accordance with the rates and rules of the District. The only exception is by written agreement with the District.

PART 2 - MATERIALS

2.01 NATIVE EARTH BACKFILL--TRENCH ZONE

Native earth backfill used above the pipe zone shall be excavated fine grained materials or loose soil free of asbestos, organic matter, roots, debris, rocks larger than 6 inches in diameter, clods, clay balls, broken pavement, and other deleterious materials. Backfill material shall be so graded that at least 40% of the material passes a No. 4 sieve. The coarser materials shall be well distributed throughout the finer material. Backfill materials that are obtained from trench excavated materials to the extent such material is available, shall be either screened directly into the trench or screened during the trenching operation. If screened during trenching, 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.

2.02 IMPORTED MATERIAL FOR BACKFILL--TRENCH ZONE

Imported material shall conform to that specified for native earth backfill or imported sand.

2.03 IMPORTED SAND--PIPE BASE AND PIPE ZONE

A. Imported sand used in the pipe base and pipe zone shall consist of natural or manufactured granular material, or a combination thereof, free of deleterious amounts of organic material, mica, loam, clay, and other substances. Under no circumstances will decomposed granite, rock dust, or native earth backfill be allowed or used in the pipe base or pipe zone areas. Imported sand shall have the following gradation or similar:

Sieve Size	Percent Passing By Weight
3/8-inch	100
No. 4	75 - 100
No. 30	12 - 50
No. 100	5 - 20
No. 200	0 - 15

B. Imported sand shall have a coefficient of permeability greater than 0.014 measured in accordance with ASTM D2434 or a minimum sand equivalent of 30 per ASTM D2419. Imported sand shall have a saturated resistivity greater than 1,000 ohm-cm, a neutral pH, and chlorides less than 100 ppm.

2.04 CRUSHED ROCK FOR BELOW GROUND INSTALLATIONS

A. Gravel or crushed rock material shall contain less than 1% asbestos by weight or volume and conform to the Standard Specifications for Public Works Construction, Section 200-1.2 and shall meet the following gradation:

Sieve Sizes	**Designated Rock Size**			
	1-1/2-Inch	**1-Inch**	**3/4-Inch**	**3/8-Inch**
	Percent Passing	**Percent Passing**	**Percent Passing**	**Percent Passing**
2 inches	100	-	-	-
1-1/2 inches	90 to 100	100	-	-
1 inch	20 to 55	90 to 100	100	-
3/4 inch	0 to 15	30 to 60	90 to 100	-
1/2 inch	-	0 to 20	30 to 60	100
3/8 inch	0 to 5	-	0 to 20	90 to 100
No. 4	-	0 to 5	0 to 5	30 to 60
No. 8	-	-	-	0 to 10

B. Use 3/4-inch size unless indicated otherwise in the Drawings.

2.05 ROCK REFILL FOR FOUNDATION STABILIZATION

Rock refill shall be crushed or natural rock having the following gradation:

Sieve Size	Percent Passing By Weight
3 inches	100
1-1/2 inches	70 - 100
3/4-inch	60 - 100
No. 4	25 - 55
No. 30	10 - 30
No. 200	0 - 15

2.06 GRANULAR MATERIAL FOR STRUCTURAL BACKFILL

A. Granular material for structural backfill shall be free of asbestos, organic materials, clay balls, and shall have the following gradation:

Sieve Size	Percent Passing By Weight
3/4-inch	100
1/2-inch	95 - 100
3/8-inch	50 - 100
No. 4	20 - 65
No. 8	10 - 40
No. 40	0 - 20
No. 200	0 - 5

B. Whenever the phrase “structural backfill material” is used in these Standard Specifications, it shall mean granular material for structural backfill as described above.

C. Excavated material may be used for structural backfill provided it conforms to the Standard Specifications for structural backfill material.

2.07 CONCRETE FOR BELOW GROUND INSTALLATIONS

A. Concrete for anchors, collars, cradles, encasements, supports, and thrust blocks shall be Class A for reinforced items and Class C for unreinforced items per Standard Specification Section 03000, except use rapid set concrete mix where indicated.

B. Provide anchor blocks at valves in pipe having rubber gasket bell and spigot or unrestrained mechanical joints.

C. Provide support blocks at valves in ductile iron pipe or steel pipe.

D. Provide thrust blocks at fittings in pipe having rubber gasket bell and spigot or unrestrained mechanical joints. Do not provide thrust blocks for ductile iron pipe with restrained joints or steel pipe having welded, flanged, or butt strap joints unless detailed on the Drawings or otherwise required.

2.08 TRENCH CUT-OFF WALLS

A. Provide ASTM C 90, Grade N-I, hollow load-bearing concrete masonry units, medium weight, moisture controlled, average compressive strength over gross area of 1,000 psi. Nominal face dimensions: 8 inches by 8 inches by 16 inches.

B. Provide ladder steel conforming to ASTM A 82.

C. Mortar and grout shall be a mixture of cement, sand, and water. Mortar shall consist of not more than one part cement to two and one-half parts sand by damp loose volume. The quantity of mixing water shall be not more than necessary for handling and placing.

2.09 REDWOOD BAFFLES

Use merchantable heart garden grade redwood per Standard Specifications for Grades of California Redwood Lumber issued by the Redwood Inspection Service. Provide seasoned or unseasoned redwood and surfaced on four sides.

2.10 WATER FOR COMPACTION

Water used in compaction shall have a maximum chloride concentration of 500 mg/l, a maximum sulfate concentration of 500 mg/l, and shall have a pH of 7.0 to 9.0. Water shall be free of acid, alkali, or organic materials injurious to the pipe or coatings. Salt water will not be allowed.

PART 3 - EXECUTION

3.01 COMPACTION REQUIREMENTS

Unless otherwise shown on the Drawings, otherwise described in the Specifications or required by the agency having jurisdiction over the area of the work, relative compaction in pipe trenches shall be a minimum as follows:

A. Pipe base--90% relative compaction.

B. Pipe zone--90% relative compaction.

C. Backfill above pipe zone not beneath paving--90% relative compaction.

D. Backfill above pipe zone in existing or new paved areas--95% relative compaction.

E. Rock refill for foundation stabilization--80% relative density.

F. Imported sand refill for overexcavation--90% relative compaction.

3.02 SHEETING, SHORING, AND BRACING OF TRENCHES

Trenches shall have sheeting, shoring, and bracing conforming with 29CFR1926, Subpart P- -Excavations, CAL/OSHA requirements, and the District's requirements.

3.03 SIDEWALK, PAVEMENT, AND CURB REMOVAL

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

3.04 BLASTING

Perform blasting operations in accordance with Standard Specification Section 02228.

3.05 DEWATERING

Provide and maintain means and devices to remove and dispose of all water entering the trench excavation during the time the trench is being prepared for the pipelaying, during the laying of the pipe, until cement mortar of exterior joints has set hard, when concrete is being deposited and during the hydration process, and until the backfill at the pipe zone and trench zone has been completed. These provisions shall apply during the noon hour as well as overnight. 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.

3.06 MATERIAL REPLACEMENT

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

3.07 TRENCH WIDTHS

A. Pipe trench widths in the pipe zone for water pipelines will be limited as follows:

Pipe Diameter	Minimum Trench Width	Maximum Trench Width
1" through 8"	O.D. + 12"	O.D. + 18"
10" through 16"	O.D. + 16"	O.D. + 24"
18" through 24"	O.D. + 20"	O.D. + 36"
27" through 36"	O.D. + 24"	O.D. + 48"

B. Trench width at the top of the trench will not be limited except where width of excavation would undercut adjacent structures and footings. In such case, width of trench shall be such that there is at least 2 feet between the top edge of the trench and the structure or footing. Where shoring or encasement is required, trench widths shall be increased accordingly.

C. Pipe trench widths for sewer pipelines shall be the sewer pipe outside diameter plus 12 inches minimum and 16 inches maximum.

3.08 TRENCH EXCAVATION

A. Perform all excavation regardless of the type, nature, or condition of the material encountered to accomplish the construction. Do not operate excavation equipment within 5 feet of existing structures or newly completed construction. Excavate with hand tools in these areas.

B. Excavate the trench to the lines and grades shown on the Drawings with allowance for pipe thickness, sheeting and shoring if used, and for pipe base. If the trench is excavated below the required subgrade, refill any part of the trench excavated below the subgrade at no additional cost to the District with imported sand. Place the refilling material over the full width of trench in compacted layers not exceeding 6 inches deep to the established grade with allowance for the pipe base.

C. Trench depth shall accommodate the pipe and the pipe base at the elevations shown in the profile on the Drawings. In the absence of such profile, the top of pipe shall be located 4 feet below the surface elevation of the centerline of the street or 3 feet below existing ground at the pipe location, whichever is lower.

D. Construct trenches in rock by removing rock to a minimum of 6 inches below bottom of pipe and backfilling with imported sand.

3.09 TRENCH EXCAVATION IN BACKFILL OR EMBANKMENT AREAS

Construct trench excavation for pipe or pipes in backfill or embankment areas in accordance with one of the following procedures:

A. Construct and compact the embankment to an elevation of 1-foot minimum over the top of the largest pipe to be installed. Excavate trench in the compacted embankment. Place pipe base material, install pipe, and backfill with pipe zone material. Construct embankment as specified in the Standard Specification Section 02200.

B. Excavate trench in the completed backfill or embankment. Place pipe base material, install pipe, and backfill with pipe zone material. Place and compact backfill above the pipe zone to the same relative compaction as the adjacent embankment as specified in the Standard Specification Section 02200.

3.10 LOCATION OF EXCAVATED MATERIAL

During trench excavation, place the excavated material only within the working area or within the areas shown on the Drawings. Do not obstruct any roadways or streets. Conform to federal, state, and local codes governing the safe loading of trenches with excavated material.

3.11 LENGTH OF OPEN TRENCH

A. Limit the length of open trench to 300 feet in advance of pipelaying or amount of pipe installed in one working day.

B. Complete backfilling and temporary or first layer paving not more than 120 feet in the rear of pipelaying.

C. Where pipelines are located beneath or adjacent to existing paved roads, backfill all trenches at the end of each workday and place temporary or first layer of paving. Clean all new and adjacent existing paved surfaces of residual excavated and backfill materials. Perform dust control operations in these areas with a self-loading motor street sweeper with operational spray nozzles at least once each working day for the purpose of keeping paved areas clean.

D. Where open trenches are not required to be backfilled at the end of the day per these Standard Specifications but in the opinion of the District's Representative pose a hazard to the public, the trench shall be surrounded with temporary chain link fence panels or be backfilled.

E. Provide ingress and egress to buildings and property at all times. Provide steel covering for vehicular access.

3.12 TEMPORARY STEEL PLATE BRIDGING

A. When backfilling operations of an excavation in the traveled way, whether transverse or longitudinal, cannot be properly completed within a workday, provide steel plate bridging with a nonskid surface and shoring to preserve unobstructed traffic flow. In such cases, the following conditions shall apply:

1. Shore the trench to support the bridging and traffic loads.

2. Steel plates used for bridging shall extend a minimum of 12 inches beyond the edges of the trench.

3. The pavement shall be cold planed to a depth equal to the thickness of the plateand to a width and length equal to the dimensions of the plate.

4. Install steel plate bridging to operate with minimum noise.

B. Maintain the steel plates and shoring.

C. Unless specified, use of steel plate bridging at any given location shall not exceed four consecutive days in any given week.

D. The following table shows the required minimal thickness of steel plate bridging required for a given trench width:

Trench Width (feet)	**Minimum Plate Thickness (inches)**
1	1/2
1-1/2	3/4
2	7/8
3	1
4	1-1/4

E. For spans greater than 4 feet, prepare a structural design by a registered civil engineer and submit to the District's Representative for review.

F. Design steel plate bridging for HS20-44 truck loading per Caltrans Bridge Design Specifications Manual. Maintain on the steel plate a nonskid surface having a minimum coefficient of friction equivalent to 0.35 as determined by California Test Method 342. The Contractor may use standard steel plate with known coefficient of friction equal or exceeding 0.35.

G. Use a Rough Road sign (W33) with black lettering on an orange background in advance of steel plate bridging. This is to be used along with any other required construction signing.l

3.13 FOUNDATION STABILIZATION

After the required excavation has been completed, the District'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 such as soft, spongy or deleterious materials exist at the exposed grade. Overexcavation shall include the removal of all such unacceptable material that exists directly beneath the pipeline to a minimum width equal to the maximum trench width and to a depth determined by the District's Representative. Backfill the trench to the established subgrade of the 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 6 inches deep to the required grade. Place imported sand on the compacted foundation stabilization and apply water to wash the sand into the voids of the rock refill material. Continue this procedure until the voids of the rock refill have been filled with imported sand. Do not apply water in such quantities that it will damage the integrity of the foundation stabilization. Rock refill material and imported sand may be placed and compacted at the same time.

3.14 CONCRETE FOR BELOW GROUND INSTALLATIONS

A. Encase pipe with concrete to the line and dimensions indicated or place concrete between the undisturbed ground and the pipe or fittings to be restrained or supported. Quantity or bearing area of the concrete against undisturbed ground shall be as shown on the Standard Drawings, Drawings, or as directed by the District's Representative. Provide temporary support on the pipe, fittings, or valves until the concrete has obtained a 3-day cure. Place concrete such that the pipe joints, fittings, or valves are accessible for repairs. Spade or rod the concrete during placement to eliminate honeycombing. Prior to backfilling of the trench adjacent to the concrete, remove all formwork from the trench including sandbags used in the work. Backfilling of the trench adjacent to the concrete will not be allowed until the concrete has cured for at least 3 days. Allow concrete to cure for at least 7 days prior to subjecting the concrete to pipeline pressure. Where rapid set concrete mix has been used, the 3-day and 7-day cure time is not required. Backfill the rapid set concrete mix as soon as the concrete is hard (approximately one to two hours) and place pipeline into service.

B. The bearing area of a thrust block shall be calculated as follows:

$$\text{Height of concrete block} = \sqrt{\frac{Bearing\ Area}{2}}$$

Width of concrete block = 2 x height

The height and width of the concrete block shall be centered on the pipe and bear against undisturbed ground.

3.15 TRENCH CUT-OFF WALLS

Install trench cut-off walls at the locations shown on the Drawings, and at 25 feet on center on slopes 35-percent and steeper. Hand cut trench walls to form a neat slot into which the concrete blocks can be laid as tight as possible to the downhill side. Place concrete blocks in horizontal layers and reinforce with ladder steel as the wall is laid. Lay blocks full-bedded in mortar to prevent leakage of grout. All head joints shall be solidly filled with mortar. Cut blocks to fit around the pipe and mortar in place. Provide weep holes in the wall to relieve hydrostatic pressure. Provide one 1/2-inch diameter weep hole for each 1.5 square foot of wall in the trench pipe zone. Grout solid all cells of the wall. Place backfill in layers being evenly brought up on each side of the cut-off wall. Compact by hand tamping. Give special attention to placing backfill in slot in trench walls.

3.16 TRENCH BACKFILLING

A. Place the specified thickness of pipe base material (imported sand) over the full width of trench and compact to the specified relative compaction. Grade the top of the pipe base ahead of the pipelaying to provide firm, continuous, uniform support along the full length of the trench for the pipe, fittings, and valves.

B. Excavate bell holes at each joint to permit proper assembly and inspection of the entire joint. Fill and compact the area excavated for the joints with the pipe base material.

C. After the pipeline has been bedded and the cement mortar used in the exterior joints has set hard, place pipe zone material (imported sand) simultaneously on both sides of the pipe, fittings, and valves, 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 that 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. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe.

D. Compact imported sand in the pipe zone by hand tamping only. Care shall be exercised in backfilling to avoid damage to pipe coatings and polyethylene encasement.

E. Push the native earth backfill or imported material for backfill carefully onto the imported sand 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. Compact backfill material in the trench zone to the specified relative compaction by mechanical compaction or hand tamping.

F. Place and compact imported sand in the pipe zone in layers not exceeding 12 inches of compacted thickness. Place and compact native earth or imported material for backfill in the trench zone in layers not exceeding 6 inches of compacted thickness.

3.17 MECHANICAL COMPACTION OR HAND TAMPING

Place imported sand and backfill materials in uniform layers of the indicated thickness. Compact each layer to the required minimum relative compaction at the optimum moisture

content. Do not use heavy duty compaction equipment with an overall weight in excess of 125 pounds until backfill has been completed to a depth of 2 feet over the top of pipe. Do not use high impact hammer type equipment except where the pipe manufacturer warrants in writing that such use will not damage the pipe.

3.18 DISPOSAL OF EXCESS EXCAVATED MATERIAL

Dispose of excess excavated material offsite. Contractor shall make his own arrangements for the disposal of the excess material and bear all costs incidental to such disposal. In open terrain, excess material may be disposed of within the right of way by spreading, provided that rocks or lumps which cannot be readily covered by spreading are removed.

3.19 FINAL CLEAN-UP AND REDWOOD BAFFLES

A. After backfilling, grade the right-of-way to the contours of the original ground and match the adjacent undisturbed ground. Make surfaces free of all cleared vegetation, rubbish and other construction wastes. Dispose of all excavated or surface rocks and lumps which cannot be readily covered by spreading. On slopes 35-percent and steeper or where rainfall would create an erosion problem as determined by the District's Representative, provide redwood baffles across the backfilled trench at the locations shown on the Standard Drawings, Drawings, or as directed by the District's Representative. Place baffles in a vertical position across the backfilled trench and level with the contours of the slope.

B. Replace in kind street improvements, such as curbs and gutters, barricades, traffic islands, signalization, fences, signs, mail boxes, etcetera that are cut, removed, damaged, or otherwise disturbed by the construction.

3.20 SLOPE PROTECTION

A. Prepare and seed all open ground within the easement or working area disturbed by the construction, not otherwise protected from erosion, or as determined by the District's Representative. After final clean-up, cultivate areas to be seeded to break up any compaction resulting from grading operations.

B. The seed mix shall be specifically developed for the area of application and shall be as shown on the Drawings. The intent of this instruction is to provide a seed mix design that is environmentally compatible with the surrounding habitat.

END OF SECTION