SECTION 33 30 00

SANITARY SEWER UTILITIES

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Supplying all labor, materials, equipment and apparatus not specifically mentioned herewith or noted on the plans, but which are incidental and necessary to complete the work specified.

B. Work shall include furnish and installation of sanitary sewer system improvements, including sewer mains, laterals, manholes, trenching, ground water control, pipe bedding, backfill and compaction of backfill, infiltration and leakage testing for gravity sewers, hydrostatic and leakage testing for force mains, dust alleviation and control, cleanup and restoration of surface in improved areas in accordance with the requirements of the Contract Documents.

C. Any and all work to be performed on the Collection System shall be inspected and approved by City Staff.

D. The Contractor shall comply with the City's NPDES Discharge permit, as updated, for discharges to the storm drain system, including adherence to all applicable Best Management Practices to prevent pollutants, including sediment, from entering the storm drains. Contractor shall also comply with the current General Permit for Construction Activity from the California Regional Water Quality Control Board and current San Mateo Countywide Water Pollution Prevention Program permit.

1.02 RELATED REQUIREMENTS AND SPECIFICATIONS

A. City Standard Detail Drawings for Sanitary Sewer Utilities.
B. Specification Section **33 31 20**, Sewer Slip-Lining
C. Specification Section **33 31 30,** Pipe Bursting
D. Specification Section **33 31 50**, Bypass Pumping.
E. Specification Section **33 39 13**, Precast Concrete Manholes.
F. Specification Section **33 39 17**, Manhole Rehabilitation
G. Specification Section **31 23 33**, Trench Excavation and Backfill
H. Specification Section **33 10 50**, Criteria for Separation of Water Mains and Non-Potable Pipelines

1.03 REFERENCE STANDARDS

A. ASTM C 900 "All Standard Applicable for SDR35, SDR26, SDR21 AND ASTM C 900 Pipe and Fittings"

B. ASTM D 2412 Standard Test Method for Determination of External Loading Characteristics on Plastic Pipe by Parallel Plate Loading

C. ASTM D 3034 "All Standards Applicable for SDR35, SDR26, SDR21 Pipe and Fittings"

D. ASTM D 3035 "Standard Specification for Polyethylene Plastic Pipe (SDR-PR). Based on controlled outside diameter."

E. ASTM D 3350 "Standard Specification for Polyethylene Plastic Pipe and Fitting".

F. ASTM F 585 Standard Practice for Insertion of Flexible Polyethylene Pipe into Existing Sewers

G. ASTM F 679 "All Standards Applicable for SDR35, SDR26, SDR21 Pipe and Fittings"

H. ASTM F 714 "Standard Specification for Polyethylene Plastic Pipe (SDR-PR). Based on Outside Diameter"

1.04 QUALITY ASSURANCE

A. All materials and equipment furnished under this Section shall be:

1. From a manufacturer who has been regularly engaged in the design and manufacture of the materials and equipment for at least five (5) years; and

2. Approved by the Engineer before installation. The Engineer shall verify that the quality is equal to the materials and equipment made by those manufacturers specifically named herein, if an alternate product manufacturer is proposed.

B. To validate that specified final elevations have been provided, the Contractor shall provide to the City applicable grade certificates. No separate payment will be made for providing such certification. All costs therefore shall be included in the various work item(s) requiring certification.

1.05 SUBMITTALS

A. Shop Drawings: Submit data to show that the product conforms to the specification requirements.

B. Materials List: Submit a list of all materials proposed to be used on the project, showing manufacturer’s name, product trade name, type, grade, and

weight. Materials list shall be submitted and approved before any installation occurs.

C. Manufacturer's Warranty: Submit manufacturer's warranty on the product and a certificate showing compliance with applicable ASTM Standards.

D. Certification for HDPE Pipe:

1. Certification by the manufacturer that all pipe and fittings furnished under this specification were manufactured, sampled, tested, and inspected in accordance with ASTM D3350 and ASTM F714. Certification shall be signed by an authorized agent of the manufacturer. Verification of product conformance with the chemical resistance and physical testing requirements (Green Book 1994 Section 207-19.5, ASTM test methods D638, D256 and D543) shall also be provided to the Engineer for approval a minimum of 15 days prior to the commencement of the scheduled work. A report of test results shall be furnished for the Engineer's review. The date the pipe was manufactured shall be included in the Certification.

2. The Contractor performing the pipe installation shall be certified and is a licensed installer of the manufacturers' system.

3. Polyethylene pipe joining shall be performed by personnel trained in the use of joint fusion and stab joint equipment. Personnel directly involved with installing the pipe shall receive training in the proper methods for handling, inserting, trimming, and finishing the pipe. The Contractor shall provide a certification of training and experience for each fusion and installing crew member.

PART 2 – PRODUCTS

2.01 GENERAL

A. Pipe sizes for pipes other than High Density Polyethylene (HDPE) are nominal inside diameter (ID) unless otherwise noted. Pipe sizes for HDPE pipes are specified by outer diameter (OD).

B. All materials delivered to the job site shall be new, free from defects, and shall show manufacturer's name, trade name, type, grade, weights, and other identifying data as specified herein.

C. Acceptance of materials shall be subject to strength and quality testing, in addition to inspection of the completed product. Acceptance of installed piping systems shall be based on inspection and testing as specified hereinafter.

2.02 SEWER MAIN PIPE MATERIALS

A. **GENERAL:**

a. Sewer mains shall be High Density Polyethylene (HDPE) unless otherwise noted on the drawings.

B. **POLYVINYL CHLORIDE PIPE (PVC)**

1. PVC SDR 26 pipes shall have push-on rubber gasket joints unless otherwise specified and shall at a minimum conform to ASTM D 3034 or ASTM F 679. Rubber gaskets shall be factory installed and conform to ASTM F 477. Pipe joints shall conform to ASTM D 3212. Pipe shall be made of PVC plastic having a cell classification of 12454 or 12364 as defined in ASTM D 1784. The size of pipe shall be as designated on the plans. Individual pipe lengths shall not exceed twenty (20) feet in length. All pipe shall be stenciled with the words “SANITARY SEWER” in 1-5/8” high block lettering with permanent ink. The words shall be repeated at 2-foot spacing along the pipe length.

2. All pipe, fittings, gaskets, joint lubricants and cements/solvents, shall be supplied by the manufacturer and installed per manufacturer’s specifications and recommendations.

C. **HIGH DENSITY POLYETHYLENE (HDPE)**

1. The CONTRACTOR shall provide polyethylene pipe as specified. The pipe shall be made to diameter and tolerances in accordance with ASTM D 3035. The minimum ratio of orthogonal diameters prior to installation shall be 0.95. All pipe shall be made from virgin grade material. The pipe shall be of the diameter as shown on the plans and furnished complete with all fittings, and other appurtenances as necessary for a complete and functional system.

2. Unless approved otherwise by the Engineer, pipe and fittings shall be **DR 17 (unless otherwise indicated on the plans)**, Extra High Molecular Weight, High Density Polyethylene PE 3408, Cell Class PE345434C, D or E per ASTM D 3350. Pipe shall be co-extruded using a melt homogenizing/plasticating extruder and appropriate die.

3. The pipe and fittings materials shall meet the requirements for Type III, Class B, Category 5, Grade P34 material as described in ASTM D 1248. Pipe and fittings shall be made in conformance with ASTM F 714 and ASTM D 3261 as modified for the specified material. The pipe shall contain no recycled compound except that generated in the manufacturer’s own plant from resin of the same specification from the same raw material pipe

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a. Pipe, fittings, and joints shall meet or exceed the following physical properties:

Property	ASTM Test Method	Nominal Value
Density, gm/cc	D 1505	0.955
Melt Index, gm/10 min.	D 1238-E	0.10
High Load Melt Index, gm/10 min.	D 1238-F	12.0
Tensile Strength @ Break, psi	D 638	4,500
Tensile strength @ Yield, psi	D 638	> 3,200
Elongation, %	D 638	> 800
Flexural Modulus, psi	D 790	136,000
Environmental Stress Cracking Resistance, F20 Hours (100 degree C)	D 1693	> 5,000
Brittleness Temperature, degree	D 746	< -180
Melting Point, degree F	D 789	261
Vicat Softening Temp, degree F	D 1525	255
Hardness, Shore D	D 2240	66
Volume Resistivity, ohm-cm	D 991	2.6x10(16th)
ASTM D 1248 Classification:	D 1248	Type III Class C, Category 5, Grade P 34
ASTM D 1248 Classification	D 1248	345434C
Recommended Hydrostatic		800 psi @ 73.4 degree F
Design Stress		400 psi @ 140 degree F

b. Pipe Color:

i. All HDPE pipes to be used shall not be black or any dark color in the interior. The inner wall shall be white, light green or natural.

ii. The outer wall shall be black, light green or natural. Orange, red, magenta or blue color are not acceptable.

c. Pipe Markings:

i. Pipe shall be marked at 3-foot intervals or less with the manufacturer's name (or trade mark), the designation ASTM D3350 and ASTM 714, including the year of issue, the letters "PE" followed by the cell classification number of the raw material compound used, the nominal pipe size in inches, the dimensional ratio, and the manufacturer's code identifying the resin manufacturer, lot number, and date of manufacture. Pipe shall be color identified by stripes, a color shell, or solid color. The pipes shall be stored and handled in accordance with

the manufacturer's recommendations and shall be less than two (2) years old at the time of installation.

ii. The average outside diameter and wall thickness of pipe and fittings shall conform to Table 1 when measured in accordance with ASTM D 2122.

Table 1

Nominal Size (inches)	Nominal OD (inches)	Minimum Wall Thickness DR17 (inches)
4	4.5	0.265
6	6.625	0.390
8	8.625	0.507
10	10.75	0.632
12	12.75	0.750
14	14.00	0.824
16	16.00	0.941
18	18.00	1.059
20	20.00	1.176
24	24.00	1.412
28	28.00	1.647
30	30.00	1.765

d. Pipe and Fittings shall be homogeneous throughout and free of:

i. Serious abrasion, cutting, or gouging of the outside surface extending to more than 10 percent of the wall thickness in depth.
ii. Cracks
iii. Kinking (generally due to excessive or abrupt bending)
iv. Flattening
v. Holes
vi. Blisters
vii. Other injurious defects

4. **Polyethylene Fittings:**

a. All polyethylene fittings shall have butt end outlets. Molded and fabricated fittings shall have a pressure rating equal to the pipe.

b. Minimum pipe wall thickness for fitting butt outlets shall be equal to the pipe wall thickness.

c. The fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties. Any pipe and fittings not meeting these criteria shall be rejected.

d. Fittings shall be no older than 6 months from the date of manufacture to the date of shipment to City of San Bruno. All fittings shall be packaged in standard commercial cardboard boxes that provide protection from shipping injuries.

e. Fittings shall be molded except fittings larger than 12" which are allowed to be factory fabricated (unless molded fittings are available). Fabricated fittings shall be manufactured using Data Loggers recording heating iron face temperatures, fusion pressure and a graphic representation of the fusion cycle. The Data Logger printout shall be part of the required submittal for the fabricated fitting. Fabricated fittings shall be manufactured by ISCO or approved equal. All fabricated fittings must be approved by the Engineer prior to installation.

f. Fittings shall be marked with the following: ASTM D3261 (Butt type); manufacturer's name or trademark; material designation; date of manufacture or manufacturing code; size (including the sizing system used, such as IPS, CTS or OD). Where the fitting size does not allow complete marking, marking may be omitted in the following sequence: size, date of manufacture, material designation, manufacturer's name and trademark.

5. Joints:

a. Pipe lengths shall be assembled in the field with butt-fused joints in accordance with ASTM D 2657 and the pipe manufacturer's written instructions shall apply. Butt-fused joints shall have internal bead projections of not more than 1/4 inch. Bead projections on the outside and inside of the pipe shall be removed. Joint strength shall be equal to or greater than the pipe and shall indicate a ductile rather than brittle fracture when tested.

b. Joint with Fusion Equipment: The fusion machine shall have hydraulic pressure control for fusing two pipe ends together and shall be equipped with gauges to monitor fusion pressures. The machine shall be equipped with an electric or gasoline engine powered facing unit to square and trim the pipe ends smooth and provide full surface contact with the heating

plate. The heating plate on the fusion machine shall be electrically heated and thermostatically controlled with a temperature gauge and be capable of maintaining 500ºF with a tolerance of 10ºF. Fusion temperature shall be as recommended by the pipe manufacturer.

c. Where excavations for pipe installation are made between manholes, the pipe shall be joined by butt-fusion or per contractor's recommendations.

2.03 WARNING TAPE

A. Warning Tape: Installation shall be in accordance with City Standard Drawing **ST-06A "Trench Construction for Sewer or Storm Mains"**.

1. Warning Tape shall be 3-inch wide **"Green"** color for with an overall minimum thickness of 6 mil and a solid aluminum foil core with minimum thickness of 3 mil. The solid foil core shall be encased between two clear layers of 100% virgin polypropylene or polyethylene film. Warning Tape shall be permanently printed on both sides with a repeating warning "**Caution: Sewer Pipe Below**" at maximum interval of 2 feet. Warning Tape shall be placed 1 foot above the top of pipe.

2.04 SANITARY SEWER LATERALS

1. Sanitary sewer laterals shall be HDPE SDR 17 unless otherwise noted.
2. Lateral sewer sizes shall be four inches (4") for single-family units and six inches (6") minimum for commercial, industrial buildings and multiple family units or as indicated on the plans.
3. Contractor shall be responsible for verifying horizontal and vertical alignment and diameter of all active sewer laterals. **Active sewer lateral is defined as one that is physically connected to the plumbing and used to convey sanitary waste.**
4. Contractor shall connect the existing active sewer lateral to new sanitary sewer lateral as shown on the plans and as specified in the Contract Documents.
5. Lateral connections to HDPE mains shall be made using electrofusion wye saddles made of polyethylene pipe compound that meets the requirements of ASTM D 1248, Class C and suitable for fusion welding to polyethylene pipe. Fusion saddles shall be as manufactured by Central Plastics Company, Driscopipe, Miller, Dupont or approved equal.
6. Connections to existing sewer house connection pipe shall be made using sleeved stainless steel flexible couplings. All flexible couplings shall conform to ASTM C 425 and shall be as manufactured by Fernco Joint Sealer Co., DFW Plastics, Inc., or approved equal.
7. Location of all sewer laterals shall be permanently marked by imprinting or carefully chiseling the letter "S" four inches (4") in height on the top of the cub above the lateral.

2.05 CLEANOUTS

A. Installation of sewer lateral cleanouts shall be in accordance with City Standard Drawings **SS-02 "Sewer Cleanout".**

2.06 PIPE BEDDING

A. Pipe bedding shall be place in accordance with City Standard Drawings **ST-06A "Trench Construction for Sewer or Storm Mains"**. Unless otherwise specified, pipe bedding for gravity sewer and force main shall be ¾" drain rock.

2.07 BACKFILL MATERIALS

A. Unless otherwise specified, trench backfill material and backfill requirements shall be as provided under City Technical Specifications **Section 31 23 33 "Trench Excavation and Backfill"** and City Standard Drawing **ST-06A "Trench Construction for Sewer or Storm Mains".**

B. The minimum depth of cover for any public sewer shall be three feet (3'). Should it be impossible to obtain the specified minimum cover, the sewer pipe shall be either encased in concrete, have a six-inch (6") concrete cap, made of ductile iron material, or backfilled with 2 sack cement slurry, as approved by the Engineer,

2.08 MINOR CONCRETE

A. Concrete for minor structures such as pipe encasements, pipe supports, replacement and repair of curb and gutter, sidewalks, and other concrete work, when designated as minor concrete on the plans, shall conform to the provisions of **Section 32 16 00 "Curb, Gutter, and Sidewalks"** of the City's Technical Specifications.

PART 3 – EXECUTION

3.01 TRENCH EXCAVATION

A. Trench excavation and backfill shall be in accordance with **Section 31 23 33 "Trenching and Backfilling"** of the City's Technical Specifications and City Standard Drawing **ST-06A "Trench Construction for Sewer or Storm Mains"**, or as noted in the contract documents and plans.

3.02 SEPARATION OF WATER MAINS AND SEWER MAINS

A. Criteria for separation of water mains and sewer mains, and other non-potable pipelines shall be in accordance with City Technical Specifications **Section 33 10 50 "Criteria for Separation of Water Mains and Non-Potable Pipelines".**

B. The minimum clearance distances between the sewer pipe bell or flange and other utility pipes, ducts, and/or structures shall be as follows for sewer pipe four inches (4") and greater:

1. Forty-eight inches (48") for adjacent or parallel utilities that are non-potable (e.g. AT&T duct, low voltage electrical, low pressure gas)

2. Sixty inches (60") for high-risk utilities (e.g. high voltage electrical and high pressure gas)

3. Twelve inches (12") for perpendicular or crossing utilities.

3.03 PIPE INSTALLATION

A. Pipe and appurtenances shall be installed in accordance with the best practice, and in conformance with the applicable requirements of ASTM D 2321 Standard Practice for Underground Installation of Flexible Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications" and these specifications. Pipe laying shall start at the low end of each section and proceed upgrade. All bell and spigot pipes shall be laid with the bell end upgrade. Excavate bell holes for each pipe joint. All pipes shall be laid on a bed prepared by handwork, dug true to line and grade, to furnish a true and firm bearing for the pipe throughout its entire length. Adjustment of pipes to line and grade shall be made by scraping away or filling in and tamping material under the body of the pipe throughout its entire length, not by blocking or wedging.

B. After each pipe had been brought to grade, aligned, and placed in final position, initial backfill is to be placed.

C. Mandatory use of shoring at designated locations shall not relieve the Contractor of the responsibility to install shoring at other locations required by the Engineer or where necessary for safety of workers or the general public.

D. Shoring shall be withdrawn only after backfill above pipe has proceeded to a height equal to or greater than three-quarters (3/4) of the excavation depth. Bottom cross bracing and wailers 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. Shoring shall be cut above the pipe and left in place only when so required on the plans.

E. The Contractor is solely responsible for installing and extracting the shoring in a manner that will not disturb the line, grade, backfill compaction, or operation of the utility being installed or adjacent utilities and facilities.

F. Place pipe that is to be bedded in concrete cradle or encased in concrete in proper position on temporary supports. When necessary, rigidly anchor or weight the pipe to prevent flotation as concrete is placed. Place concrete for cradles, arches or encasement uniformly on each side of the pipe and deposit at approximately its final position. Concrete placed beneath the pipe shall be sufficiently workable so that the entire space beneath the pipe can be filled without excessive vibration.

G. At the end of each workday, all open ends of pipe installed shall be plugged to the satisfaction of the Engineer.

3.04 LATERAL INSTALLATION

A. Unless otherwise noted on the plans, all sanitary sewer lateral shall terminate at the property line.

B. In cases where there are form of obstructions in the field during sewer lateral installation (e.g. fences, retaining walls, decorative blocks, pavers, etc.), Contractor shall determine the feasible and appropriate location of new lateral. No additional compensation will be made if the new lateral location differs from what is shown on the plans and detail drawings.

C. Existing sewer laterals shown on the drawings are schematic only. Contractor to field verify all active laterals prior to the installation of new ones. No additional compensation will be made to the Contractor for assessing whether the existing lateral is active or inactive.

3.05 CONNECTIONS TO EXISTING MANHOLES

A. Pipe connections to existing manholes shall be performed in accordance to City Standards and other applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping of channel.

B. All PVC and HDPE pipe entering or leaving a manhole shall have a rubber sealing gasket as supplied by the pipe manufacturer, firmly seated perpendicular to the pipe axis, around the pipe exterior and cast into the structure base or near the wall center as a water stop. Water stop may also consist of a manhole coupling with rubber sealing rings cast into the structure base.

C. Existing flow shall be maintained through a bypass. A bypass plan shall be submitted and the Contractor shall be solely responsible for maintaining the bypass and shall be liable for any fines levied by any agency as a result of any spill or overflow.

3.06 CONNECTIONS TO EXISTING PIPE

A. The Contractor shall provide fittings or adapters required to connect new pipe to existing pipe. Detail drawings of such fittings or adapters and the method of connection shall be submitted to the Engineer for approval.

B. Pipelines shall be connected to existing mains as indicated on the drawing. Each connection shall be made at a time and in a manner that will result in the least interruption of service.

3.07 RECONSTRUCTION OF EXISTING STRUCTURES

A. General: The Contractor, when removing existing structures located on live systems, shall take precautions to ensure that no foreign material enters into the existing sewer lines. Care shall be taken and proper methods employed to prevent dirt, rock, concrete, brick, wood, etc., from entering into the live lines. During the period of time in which the Contractor is working on a live sewer system, City maintenance crews shall have continuous access to the structure. All work on the structure shall be complete within 3 days after the original structure is removed.

B. Structure Adjustments and Repair: When work is performed on existing manholes, plywood shall be used to cover entire channel and a drop cloth be used to cover the entire base. This precaution shall be taken to prevent debris from entering the Collection System. This precaution shall remain in place during all work, and when work is complete, shall be removed along with all debris.

C. Reuse of Material: Existing precast material, adjustment rings, frames and covers removed in adjustments and/or repairs may be reinstalled only when such undamaged items are permitted by the Engineer.

3.08 SANITARY SEWER PLUGS

A. All ends of sanitary sewers provided for future connection shall be plugged with "Polycap" stoppers providing the same joint characteristics as specified for the sanitary sewer main or lateral.

3.09 ABANDONMENT OF SANITARY PIPES AND MANHOLES

A. Gravity Sewer and Force Mains:

Gravity sewer or force mains to be abandoned shall be plugged with mortar and an eight inch (8") thick concrete brick wall. The facility being abandoned shall be filled with sand or concrete slurry and plugged. No timber bulkheads shall be allowed.

B. Laterals:

Some existing buildings use common or shared laterals. The Contractor shall determine if the lateral is common/shared or active prior to abandonment. Contractor shall be responsible for any additional cost to reinstate the active lateral that is abandoned.

1. The downstream end of the lateral shall be sealed with a manufactured watertight cap/stopper made specifically for the purpose of sealing/capping the end of a sanitary sewer. The cap/stopper shall be installed per manufacturer's recommendation and in such a way to prevent any source of water from entering the sanitary sewer system. Any device or material that may slide into the lateral and potentially cause a blockage or obstruction in the mainline sewer will not be allowed. The cap/stopper shall be installed on a defect free portion of the lateral immediately before the wye connection to the city main. If defects are found in the wye connection, the Contractor shall excavate toward the main and the wye shall be removed and replaced with a new portion of equally sized pipe.

2. The remaining portion of the lateral from the point of termination to structure shall be sealed at both ends with a manufactured watertight cap/stopper made specifically for the purpose of sealing/capping the end of a sanitary sewer. The cap/stopper shall be installed on a defect free portion of the lateral. If defects are found then the Contractor shall excavate the lateral until a defect free portion of the lateral is located.

3. If at least one service from the common lateral is intended to remain, the connecting fitting for the laterals shall be removed and replaced with a new section of straight pipe or an elbow of sufficient angle to provide a smooth transition between the existing portions of the lateral. Elbow shall be a manufactured fitting and shall be installed per manufacturer's recommendation to assure a watertight seal.

C. Manholes:

1. The Contractor shall remove the frame and cover to be salvage and transport to City of San Bruno Corporation Yard.

2. The Contractor shall remove the structure to at least 2 feet below finished grad, break or perforate the bottom of the structure to provide drainage, and backfill the structure with compacted borrow fill.

3.10 REPAIR/RESTORATION OF PROPERTY

A. Any repair or restoration work resulting from Contractor's activity shall be completed within twenty-four (24) hours. Contractor may use the sod saved from the existing lawn or use new sod/seed to match existing lawn. Any concrete or other repair shall match existing. Contractor shall maintain the new planting for a minimum thirty (30) day period.

3.11 TESTING SANITARY SEWERS

A. Sanitary sewer systems, including main sewers and laterals, shall be tested for tightness, alignment, cleanliness, and compliance with these Standards after completion of all backfilling and prior to request for final inspection. Contractor shall notify the Engineer at least five (5) working days in advance of proposed testing dates. All testing shall be performed under the presence of the Engineer. No payment will be made nor will any permit be signed off without the successful completion of all phases of testing.

B. The Contractor shall take all necessary precautions to prevent any joint from drawing ground water while the pipeline and its appurtenances are being tested. Contractor shall, at own expense, correct any excess leakage and repair any damage to the pipe, structures, and appurtenances resulting from or caused by this test. Where the actual leakage exceeds the allowable leakage, the Contractor shall discover the cause and remedy it before the test is accepted. If the leakage is less than that allowed and leaks are observed, such leaks shall be repaired at the Engineer's direction.

C. Gravity Sewers

1. Tests of gravity sewers shall be made from end of pipe or manhole to manhole unless grades are flat enough to permit testing of two or more sections at one time.

2. Main sewers shall be tested after they have been inspected and cleared of obstructions and following backfill, but prior to repaving. Each section of sewer shall be tested between successive manholes

by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers.

3. At the Contractor's option, either the hydrostatic or the air test may be used for gravity sewer mains. The Engineer shall require video inspection be performed on newly constructed sewer mains and laterals. The Contractor shall pay for all associated testing costs.

D. Hydrostatic Test for Gravity Mains:

1. Fill the pipe and manhole with water to a point four feet (4') below the ground surface of the upper manhole, but in no case less than four feet (4') above the pipe invert. If ground water is present, the water surface in the upper manhole shall be at least four feet (4') above the level of the ground water. The line shall be filled at least one (1) hour prior to testing and shall be tested at least two (2) hours, maintaining the head specified above with measured additions of water. The sum of these additions shall be the leakage for the test period.

2. The maximum allowable head of water above any portion of sewer being tested shall be fifteen feet (15'). Where the difference in elevation between successive manholes exceeds fifteen feet (15'), a "Test Tee" shall be installed between manholes, and testing shall be carried on between the tee and the manhole.

3. The allowable leakage shall not exceed one-tenth gallon (0.1) per minute per inch diameter per one thousand feet (1,000') of main line sewer being tested for a two (2) hour duration test.

E. Air Test for Gravity Mains:

Air test shall be applied to each length between adjacent manholes, and the procedure shall be as follows:

1. Pressurize the test section to approximately four (4.0) psig. After this pressure is reached, allow pressure to stabilize. The pressure will normally drop as the air temperature stabilizes. This will usually take two (2) to five (5) minutes, depending on the pipe size. The pressure should be reduced to three and five-tenths (3.5) psig before starting the test. Start the test when the pressure is at three and five-tenths (3.5 psig). If the pressure drops below two and five-tenths (2.5) psig in less than the time given in the following table, the section of pipe shall not have passed the test:

Size	Minimum Time per 100 ft. Test Section
4”	1 min. 53 sec.
6”	2 min. 50 sec
8”	3 min. 47 sec
10”	4 min. 43 sec.
12”	5 min. 40 sec.
15”	7 min. 05 sec.
18”	8 min. 30 sec.
21”	9 min. 55 sec.
24”	11 min. 20 sec.
27”	12 min. 45 sec.

2. When the prevailing groundwater is above the line being tested, air pressure shall be increased forty-three hundredths (0.43) psig for each foot the water table is above the invert of the line.

3. The pressure gauge used shall be supplied by the Contractor, shall have minimum divisions of one-tenth pound per square inch gauge (0.10 psig), and shall have an accuracy at least of four-hundredths of a pound per square inch gauge (0.04 psig). The gauge shall have been calibrated within forty-five (45) calendar days of the air test and the calibration tag shall be affixed to the gauge.

4. The gauge assembly shall be equipped with three-quarter inch (3/4") IPT nipple and isolation valve to allow the Engineer to install a second gauge.

5. The City may test pressure gauges for accuracy.

F. Mandrel Testing of Gravity PVC and HDPE Sewer Mains:

1. The Contractor shall pull a mandrel through each segment of installed PVC sewer main to test the amount of deflection incurred during installation. This test shall be done after the pipe trench has been backfilled and compacted to the level of the pavement subgrade in paved areas or to the ground surface in unpaved areas. The Engineer shall observe mandrel testing. The Contractor shall give at least a five (5) working-day notice to the Engineer before commencing mandrel testing.

2. Mandrels shall be full circle, solid or rigid odd numbered (nine leg minimum) steel cylinders with pulling rings at each end and approved by the Engineer. The circular cross section of the mandrel shall have a diameter no smaller than ninety-five percent (95%) of the average inside diameter of the pipeline being tested. The length of the mandrel shall be no less than two times the full cross section diameter. A separate pull line shall be attached to each pull ring to facilitate removal of the mandrel if an obstruction is encountered.

3. Mandrels shall be pulled through the pipeline by hand without the aid of mechanical pulling devices. Any deficiencies found by mandrel testing shall be corrected by the Contractor, at the Contractor's expense. Deficiencies shall be repaired by excavating the pipe at least to the pipe spring line. Pipe bedding and backfill shall be re-compacted after the repair. Internal rounding or vibration to correct deflection shall not be permitted. After repair and re-compaction of the pipe bedding and trench backfill material, the pipe shall be retested using the mandrel. Any pipe failing two mandrel tests shall be replaced.

4. PVC Sewer Mandrel Sizes:

Pipe Size (inches)	Mandrel O.D. (inches)
6	5.619
8	7.524
10	9.405
12	11.191
15	13.849
18	16.924
21	19.952
Over 21	Follow Manufacturer's Spec.

5. HDPE ,mandrel size shall be 95% of average inside diameter of pipe installed.

G. Sewer Force Mains

1. Sewer force mains shall be tested using hydrostatic pressure. The Contractor shall pay for all associated testing costs.

2. In the event that any portion of the new gravity sewer main, lateral or sewer force main are found to be deficient during any phase of the testing, repairs shall be made within a reasonable time frame and in

conformance with these specifications. All repairs shall be retested and shall be re-televised (if video inspection is required) at the Contractor's expense.

H. Hydrostatic Testing for HDPE Sewer Force Main

1. A certified Distribution System Operator must be present for all hydrostatic testing, chlorination, flushing, bacteria testing and connections to the existing system per California Department of Health Services, Operator Certification Regulations, Section 63770. The Engineer must receive the request for the certified Operators to be present for these operations in writing no less than six (6) working days prior to the anticipated date of work.

2. The Contractor shall give a minimum of six (6) working days written notice to the Engineer Division to schedule filling and testing of the pipeline.

3. Testing shall be in accordance with ASTM F2164, "Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure." Selected precautions and requirements of ASTM F2164 are repeated below:

   a. The maximum test pressure for pressure-rated polyethylene piping is not to exceed 1.5 times the system design pressure where lower pressure-rated components or devices are not present, or have been removed or isolated from the test section.

   b. The maximum test pressure is not to exceed the pressure rating of the lowest pressure-rated component in the test section, where lower pressure-rated components or devices cannot be removed or isolated from the test section. Consult the component manufacturer for pressure ratings.

   c. The hydrostatic test shall be of at least a 5-hour duration.

      - Add make-up water as necessary to maintain maximum test pressure for four (4) hours.

      - Test Phase – Reduce test pressure by ten (10) psi and monitor pressure for one (1) hour. Do not increase pressure or add make-up water.

      - Test pressure shall not vary by more than 5% of the test phase pressure for the one hour duration of the test phase.

   d. When properly made, heat fusion joints in polyethylene pipe are as strong as the pipe and do not leak. Leakage at a fusion joint indicates a faulty joint that may rupture completely at any time. If

leakage is observed at a fusion joint, move away immediately, and depressurize the test section.

4. Before Testing

   a. The interior of the pipeline shall be thoroughly cleaned, and the trench backfill, except permanent pavement, shall be completed.

   b. The concrete thrust or reaction blocks shall be cured for at least seven (7) calendar days.

5. Test Equipment Set-Up

   a. Contractor shall furnish hoses, pumps, pressure gauges, leakage-measuring device, connections, relief valves, other necessary apparatus, and personnel required for making the tests.

   b. Where an existing water supply is used to supply test water, protect the existing water supply from backflow contamination. Remove backflow protection and isolate the test section from the existing water supply before testing.

   c. The pressure gauge or sensor shall be accurate to within two percent (2%) of full scale. The gauge or sensor full scale value shall be no more than twice the test pressure, and the scale graduations be no greater than two percent (2%) of the full scale value. The gauge shall have been calibrated within forty-five (45) calendar days of the hydrostatic test and the calibration tag shall be affixed to the gauge.

   d. The gauge assembly shall be equipped with three-quarter inch (3/4") IPT nipple and isolation valve to allow the Engineer to install a second gauge.

   e. The City may test pressure gauges for accuracy.

6. Pressurization.

   a. After the pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure of at least 1.5 times the working pressure at the point of testing.

   b. Test pressure shall not be less than 1.25 times the working pressure at the highest point along the test section.

   c. Each valve section of pipe shall be slowly filled with water.

   d. Before applying the specified test pressure, air shall be expelled completely from the section of pipe under test. If permanent air vents are not located at all high points, corporation cocks shall be installed at such points so that the air can be expelled as the line is filled with water.

After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied.

e. To allow air to escape from the test section, flow velocities during filling shall not exceed the capacities of air release devices or other openings used to release entrapped air.

f. To avoid or limit transient pressure surges, the filling flow velocity shall not exceed the design velocity of the piping system.

g. Allow water to stand in the pipe for 24 hours before test pressure is applied.

h. During this period, valves and exposed connections shall be examined for leaks, and all visible leakage shall be repaired.

7. Hydrostatic Pressure and Leakage Test

a. The specified test pressure (based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge) shall be applied by means of a pump connected to the pipe.

b. Maintain the test pressure, +/- 5 psi, for a minimum of four (4) hours. Once the test pressure has been maintained for at least four (4) hours, reduce test pressure by 10 psi and monitor pressure for one (1) hour. Do not increase pressure or add make-up water. If no visual leakage is observed and pressure during the test phase remains steady (within 5% of the test phase pressure) for the one (1) hour test phase period, a passing test is indicated.

c. All exposed pipe, fittings, valves, and joints shall be examined carefully during the test.

d. There is no leakage allowance for a section of heat-fusion joined polyethylene piping, because properly made heat fusion joints do not leak.

e. An inspection for leaks along the pipeline shall be made by the Contractor while pipe is under pressure. Any leaks found shall be recorded by the Contractor and the record provided to the City.

8. Repairs and Retests

a. Repair all known leaks and retest the pipe until the hydrostatic pressure and leakage test is successfully completed.

b. If retesting is necessary, depressurize the test section and correct any faults or leaks in the test section. Do not attempt to correct faults or fix leaks while the test section is under pressure. Depressurize the test

section by reducing pressure or releasing test liquid at a controlled rate. Sudden depressurization can cause water hammer.

c. Repairs shall be made subject to the approval of the Engineer.

1. Excavate where required to locate and repair leaks or other defects that develop under the test. Remove backfill and paving already placed.

2. After repairs, backfill and pave in same manner as initial work.

3.12 CLEANUP

Upon completion of sanitary sewer construction operations, all lines, manholes, and other structures shall be thoroughly cleaned of dirt, rubbish, debris and obstructions of any kind to the satisfaction of the Engineer, and the entire work site shall be cleaned of all waste, rubbish, and construction debris of any nature.

- END OF SECTION -