SECTION 02530 - SANITARY SEWER COLLECTION SYSTEM SPECIFICATIONS

PART 1 - GENERAL

Materials for use at any location in the Sanitary Sewer system (extensions or existing) shall meet the requirements as set forth in the following Articles under this Section, or as noted and/or detailed on the project plans.

PART 2 – PIPE, PIPE JOINTS AND FITTINGS

2.1 GRAVITY SEWER

A. Rigid Plastic Pipe, Joints and Fittings: Pipe for use under this heading shall be of the bell and spigot type. All pipe and materials shall be made from P.V.C. components in accordance with A.S.T.M. specification D1784 for rigid polyvinyl chloride compounds. The pipe bell shall be an integral part of the pipe barrel. The spigot end of each pipe length shall be beveled to permit making up the joint. All pipe spigot ends shall be marked to show full make-up joint depth. All pipe shall meet or exceed the strength requirements when tested in accordance with A.S.T.M. specification D3034.

1. Pipe Joint: All pipe shall be joined by means of a rubber ring slip joint. Cement weld or glued joints will not be permitted. The slip joint shall be formed by a bell joint. The bell joint shall be an integral and homogenous part of the pipe formed by extrusion, with a ring groove for seating the rubber ring gasket. The rubber ring gasket shall be partially split or perforated to permit expansion and contraction with respective increased or decreased pressure in the main.

2. Pipe Fittings: Lateral service line connected to the sewer main shall be made with wye type fittings inserted in the sewer main piping. Service laterals shall be installed as shown on the plans, or as directed. Each service lateral or wye shall terminate with a rubber faced expander plug to fully seal the open pipe end until same is required for service. Pipe fitting materials shall be the same as that specified for the piping materials. All fitting joints shall be sealed using rubber ring gaskets as previously specified.

All gravity sanitary sewer main and lateral service lines shall be SDR 35 and shall be supplied in lengths best suited for construction of the project.

B. Ductile Iron Pipe, Joints and Fittings: Pipe for use under this heading shall be Class 50. This material shall meet the following minimum physical strength requirements of 60,000 psi. tensile, 42,000 psi. yield, and ten (10) percent maximum elongation. Each piece of pipe shall have the; weight, thickness, class manufacturer's mark, the year of manufacture, and the letters DI or word "DUCTILE" clearly stamped on the pipe. The pipe materials and construction shall be in accordance with all the requirements of ANSI Standard A21.51 (A.W.W.A. C-151-65). The pipe may be furnished with mechanical, push on, or flange joint ends as detailed on the plans or as required.

1. Mechanical Joint Pipe and Fittings: Pipe and fittings of this joint type shall be furnished complete with all glands, gaskets, tee head bolts, hex nuts, etc., all properly sized and manufactured for the required pipe and fitting sizes. All fittings and bends shall be constructed of cast or ductile iron. Materials for this service shall consist of durable, solid, cast or ductile iron meeting the minimum physical requirements of 18,000 psi. tensile strength and 40,000 psi. modulus of rupture. Fittings and bend items shall be designed and tested to permit a minimum working pressure of 250 psi. prior to being shipped from the factory. All mechanical joint fittings, bends, and joint accessory materials shall conform to ANSI Standard A21.10 and A21.11.

2. Slip Joint Pipe and Fittings: Slip joint pipe shall be made of ductile iron as previously specified. The plain end of the pipe shall be tapered to permit easy assembly. The pipe joint gasket shall meet all applicable requirements of ANSI Standard A21.10 with joints in accordance with Section 11-2.3 of U.S.A. Standard A21.11. Fittings and bends for use with slip joint piping shall be mechanical joint as previously specified.

3. Flanged Pipe and Fittings: Pipe for use with flanged ends shall be ductile iron as previously specified. Threads for the screwed-on flanges shall be designed in accordance with U.S.A. Standard B 2.1. Flanges for use shall be faced and drilled in accordance with U.S.A. Standard B 16.1, 125 lb. All joint and joint materials, shall be designed and tested for a minimum working pressure of 250 psi. Flanged branch fittings and bends shall meet or exceed the pipe and joint

materials requirements. The flange joint bolt circle and drilled holes shall match those of U.S.A. Standard B 16.1, 125 lb. All pipe and fittings shall be furnished with the properly sized bolts, nuts, and best quality, 1/8-inch-thick rubber gaskets. The interior surface of all pipe and fittings shall be coated with an approved epoxy lining, factory applied.

2.2 FORCE MAINS

A. PVC Force Mains

1. Pipe: PVC pipe shall conform to AWWA C-900 and be pressure class 200 with a dimension ratio (SDR) of 14. Gaskets shall conform to ASTM D-1869.

2. Fittings for PVC Pipe: Fittings for 2" pipe shall be mechanical joint ductile iron fittings meeting the requirements of ANSI/AWWA C111/A21.11. Fittings shall include appropriate transition gaskets.

   For pipe sizes 3" and larger, flanged and/or mechanical joint ductile iron fittings for PVC pipe shall be used and shall meet the requirements of ANSI/AWWA C110/A21.10 and ANSI/AWWA C153/A21.53, respectively. Fittings shall include appropriate transition gaskets.

   Solvent cement welded joints conforming to ASTM Standard D2564 may be used for pipe sizes less than 2".

3. Pipe and Fitting Compound: PVC compounds shall be white in color for improved exposure resistance and shall comply with ASTM D-1784, Rigid Poly (Vinyl Chloride) Compounds with physical properties and chemical resistance of cell classifications for pipe of 12454-B, 12454-C, or 14333-D and cell classifications for fittings for 12454-B, 12454-C, or 13343-C. Different cell classifications having one or more superior properties and clean rework material generated by the manufacturers' own production shall be acceptable.

4. Joints: Joints of both pipe and fittings shall comply with ASTM D-3139, Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals. Qualification test of the joint design shall result in no leakage under various laboratory test conditions of joint alignment at 2<< times rated pressure and at 22" mercury vacuum.

5. Gaskets: Gaskets shall be molded from a high grade, properly vulcanized, elastomeric compound consisting of either a basic natural or synthetic rubber. Gaskets shall be marked to show pipe size and type.

   NOTE: Specifications for Elastomeric Seals for Thermoplastic Pipes are being developed by ASTM. Until they are published, the compound for elastomeric seal rubber gaskets shall generally comply with modified physical requirements of ASTM Standard Specifications: D-1869, Rubber Rings for Asbestos Cement Pipe; C361, Reinforced Concrete Low-Head Pressure Pipe; and AWWA Standard C III for Rubber Gasket Joints for Cast-Iron Pressure Pipe and Fittings.

6. Air/Vacuum Release Valves: Air/Vacuum Release Valves shall be Valmatic or approved equal with steel floats, Buna-N seating and cast-iron housing. Air/Vacuum valves shall be located as depicted in the construction drawings and installed as detailed in the construction drawings.

7. Gate Valves: All gate valves shall be non-rising stem, cast-iron body and wedge, bronze trim and stem, resilient seat gate valves conforming to AWWA C515, unless otherwise indicated. The disc shall have a resilient rubber seat ring mounted securely with stainless steel, screws. All internal parts shall be epoxy coated. The valve stem seal shall be double "O"-ring and shall contain an anti-friction washer. Each buried valve shall have a cast iron/bituminous coated valve box. Valve box shall be Tyler Pipe 564-S or approved equal. Each buried valve shall include a valve box alignment device such as a BoxLok by EMMA Sales, LLC or approved equal. Each buried valve, which is not located within pavement, shall have a carsonite glass fiber/resin reinforced composite utility stake with the words "sewer valve." The utility stake shall be "green" in color with "white" lettering. The valve shall be as supplied by Mueller, Clow, American or approved equal.

8. Restrained Joint PVC Pipe

- Restrained joint PVC pipe shall meet the performance requirements of AWWA C-900 or AWWA C-905. The PVC compound shall meet cell classification 12454 per ASTM D1784. All joints shall meet the requirements of ASTM D3139. O-rings shall meet the requirements of ASTM F477 "Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.)
- Restrained joint PVC shall be installed using a "permanent" joint system. Joint system shall provide a noncorrosive restrained joint by using machined grooves on the pipe and in the coupling which, when aligned, allow a spline to be inserted locking the pipe and coupling together. Provide an o-ring in the coupling to create a hydraulic seal. The SDR designation and the pressure class designation shall be as shown on the approved plans.

9. Mechanical Joint Restraints

i. Restraint devices for nominal pipe sizes 3 inch through 36 inch shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110-A221.10.

ii. The devices shall have a working pressure rating equal to that found in the most current product brochure. Ratings are for water pressure and must include a minimum safety factor of 2:1 in all sizes.

iii. Gland body, wedges and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536.

iv. Three (3) test bars shall be incrementally poured per production shift as per Underwriter's Laboratory (U.L.) specifications and ASTM A536. Testing for tensile, yield and elongation shall be done in accordance with ASTM E8.

v. Chemical and nodularity tests shall be performed as recommended by the Ductile Iron Society, on a per ladle basis.

B. Ductile Iron Force Mains:

1. Ductile Iron Pipe, Joints and Fittings: Pipe for use under this heading shall be Class 50. This material shall meet the following minimum physical strength requirements of 60,000 psi. tensile, 42,000 psi. yield, and ten (10) percent maximum elongation. Each piece of pipe shall have the; weight, thickness, class manufacturer's mark, the year of manufacture, and the letters DI or word "DUCTILE" clearly stamped on the pipe. The pipe materials and construction shall be in accordance with all the requirements of ANSI Standard A21.51 (A.W.W.A. C-151-65). The pipe may be furnished with mechanical, push on, or flange joint ends as detailed on the plans or as required. Ductile iron piping shall be used for the discharge piping in the wet well, valve vault, and meter vault and shall transition to PVC force main piping as shown on the plans and matching the specifications in this section.

- Mechanical Joint Pipe and Fittings: Pipe and fittings of this joint type shall be furnished complete with all glands, gaskets, tee head bolts, hex nuts, etc., all properly sized and manufactured for the required pipe and fitting sizes. All fittings and bends shall be constructed of cast or ductile iron. Materials for this service shall consist of durable, solid, cast or ductile iron meeting the minimum physical requirements of 18,000 psi. tensile strength and 40,000 psi. modulus of rupture. Fittings and bend items shall be designed and tested to permit a minimum working pressure of 250 psi. prior to being shipped from the factory. All mechanical joint fittings, bends, and joint accessory materials shall conform to ANSI/AWWA C153/A21.53.

- Slip Joint Pipe and Fittings: Slip joint pipe shall be made of ductile iron as previously specified. The plain end of the pipe shall be tapered to permit easy assembly. The pipe joint gasket shall meet all applicable requirements of ANSI Standard A21.10 with joints in accordance with Section 11-2.3 of U.S.A. Standard A 21.11. Fittings and bends for use with slip joint piping shall be mechanical joint as previously specified.

- Flanged Pipe and Fittings: Pipe for use with flanged ends shall be ductile iron as previously specified. Threads for the screwed-on flanges shall be designed in accordance with U.S.A. Standard B 2.1. Flanges for use shall be faced and drilled in accordance with U.S.A. Standard B 16.1, 125 lb. All joint and joint materials, shall be designed and tested for a minimum working pressure of 250 psi. Flanged branch fittings and bends shall meet or exceed the pipe

and joint materials requirements. The flange joint bolt circle and drilled holes shall match those of U.S.A. Standard B 16.1, 125 lb. All pipe and fittings shall be furnished with the properly sized bolts, nuts, and best quality, 1/8-inch-thick rubber gaskets. The interior surface of all pipe and fittings shall be coated with an approved epoxy lining, factory applied.

PART 3 - MANHOLES

3.1 MANHOLES

A. Pre-Cast Manholes: Pre-cast manhole straight sections with eccentric top or cone sections may be used for manhole construction. Base sections and barrel sections, with properly located inlet and invert gasketed openings sized for sewer main as required, may be used. As will be noted from the plant profile segments, most manholes are designed for two tenths (0.2) foot of fall across the manhole. All manhole sections shall be fitted with or provided with rubber coated manhole steps. Concrete for all pre-cast manhole sections shall be designed of ingredients that will produce a minimum 3,500 psi. compressive strength at 28 days. All sections shall be fully reinforced with welded wire fabric.

B. External joint wrap all riser joints to ensure seal. No grout is permitted on the interior of manhole riser joints prior to acceptance tests.

C. The discharging manhole from a pressurized sewer, in addition to the two downstream manholes, shall be lined with a monolithic multi-layer/component concrete manhole – wet-well lining system to provide infiltration and corrosion protection. See Part 8 – Manhole Installation; Section 8.4 OBIC Lining of Manholes in this specification. Lining system shall be installed in all new lift station wet wells.

D. Manhole Frames and Covers: Shall be of the type and duty as shown on the manhole plans. Iron castings shall conform to the latest revisions of ASTM and specification A-48, Class 20. All castings for use shall be true to pattern in form and dimensions, free from faults, sponginess, cracks, blowholes, and other defects. The bearing surfaces, between frames and covers, shall be machined, fitted together, and match marked, to prevent rocking.

E. Wrap manhole frame and adjustment rings with pre-approved external sealing material, minimum 3-inches beyond joint between ring and frame and adjustment rings and precast section.

PART 4 – PIPE BEDDING & ENCAPSULATION

4.1 Materials to be used for this purpose shall consist of fine, clean, durable particles of crushed stone. Crushed stone used for this purpose shall consist of well graded materials passing a 1-inch sieve to dust. All installed sanitary sewer pipe will consist of pipe bedding material 4” below the pipe to a minimum of 6” above the pipe.

PART 5 – LIFT STATIONS

Contact District Engineer for site specific requirements.

PART 6 – GRINDER PUMP STATIONS

Contact District Engineer for site specific requirements.

PART 7 – CONNECTION TO PRESENT SYSTEM

7.1 MATERIALS

A. Materials to be used for connections to the present system shall be in accordance with the preceding Articles as applicable, under this Section of these specifications. Installation and testing of all items shall be in strict accordance with the following Section of these specifications. Under all circumstances, extreme care must be exercised when connecting to the present system. Foreign materials of whatever nature, must not be permitted to enter the system.

B. The Contractor shall notify the District and Owner prior to connection so that proper notification to those affected may be provided. Where system segment shut-down is required, the actual shut-down is not to be done until all connection materials, equipment, and personnel are at the site, and the existing system

point of connection has been exposed, thoroughly cleaned, and prepared for immediate installation of the connection materials. All personnel shall be thoroughly instructed as to the procedure to be followed and ready for work. All connections are then to be made in an efficient manner requiring the least amount of time and maximum amount of care.

C. Existing manholes shall be core bored or provided with a smooth cut for connection of new mains or services. The pipe to base connection shall be made using a rubber gasket around the pipe barrel with sufficient flap to act as a water stop when sealed in the hole with non-shrink filler grout. An asphaltic-fibre cement shall be used over the joint connection around the full pipe diameter, after the filler grout has hardened. Concrete for additional support of the connecting sewer main, shall be placed under the piping adjacent to the manhole base.

PART 8 – HIGHWAY CROSSING MATERIALS

8.1 SEWER MAIN

Pipe to be used for this purpose, unless otherwise shown on the plan and/or details, shall be as specified under Article 2 of the specifications. Fittings for use in the right-of-ways shall be of the joint type as shown and as detailed on the plans. All fittings shall meet the requirements as stated under Article 2 of the specifications.

8.2 PIPE ENCASEMENT

A. All sewer mains crossing a private or public road shall be encased unless waived by the District.

B. All sewer main larger than two (2) inches in diameter shall be placed in or through an encasement tube consisting of over-sized steel pipe or, in the case of force main, restrained-joint PVC pipe. The encasement tube inside diameter shall be as shown on the plans. Materials to be used for steel encasement tube shall consist of new steel pipe in not less than ten (10) foot lengths. The materials used for the encasement tube construction shall have minimum yield strength of 35,000 psi and a minimum tensile strength of 60,000 psi, per ASTM A139-Grade B. All joint ends shall be cut at 90 degrees to the longitudinal axis of the pipe. Each end shall be beveled, and joints shall be butt welded around the entire perimeter of the pipe. The encasement tube shall have a minimum wall thickness of 0.250 inches or as required by permitting governing authority.

C. Materials used for PVC encasement tube shall consist of new restrained-joint pipe in not less than twenty (20) foot lengths meeting the performance requirements of ASTM D2241. The PVC compound shall meet cell classification 12454 per ASTM D1784. All joints shall meet the requirements of ASTM D3139. O-rings shall meet the requirements of ASTM F477 “Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.”

D. Restrained-joint PVC shall be installed using a “permanent” joint system. Joint system shall provide a noncorrosive restrained joint by using machined grooves on the pipe and in the coupling which, when aligned, allow a spline to be inserted locking the pipe and coupling together. Provide an o-ring in the coupling to create a hydraulic seal.

E. The SDR designation and pressure class designation shall be determined by the District.

F. Encasement Spacers: Casing spacers shall be projection type, totally non-metallic, constructed of preformed sections of high-density polyethylene. Spacers shall be ISO 9002 certified for strength and quality and spaced along carrier pipe as shown in the approved plans. Spacers shall be manufactured by RACI or approved equal.

PART 9 – CONCRETE FOR PIPE ENCASEMENT AND/OR SUPPORT

Concrete to be used for pipe encasement and support shall consist of ingredients designed to produce a mixture having a 3,500 psi., compressive strength at 28 days curing time. The mix shall be as “dry” as possible using only sufficient water to permit mixing and placement. Excessive water will not be permitted. Cement for use shall be the “high early” type to provide initial set as soon as possible. Concrete may be placed and covered with earth fill to prevent freezing during periods of cold weather. However, frozen ingredients will not be permitted for use. All

concrete used and placed for this purpose shall be given at least three (3) days curing time before being placed under stress.

PART 10 – POLYETHYLENE ENCASEMENT FOR DUCTILE IRON PIPE.

This Article covers materials for polyethylene encasement to be applied to underground installations of ductile iron pipe, fittings, valves, and other appurtenances.

Polyethylene film shall be manufactured of virgin polyethylene material conforming to the following requirements of A.S.T.M. Standard Specifications D-1248-78 for Polyethylene Plastics Molding and Extrusion Materials:

10.1 Raw material used to manufacture polyethylene film:

Type: 1
Class: A (natural) or B (black)
Grade: E-1
Flow rate: 0.4 maximum
Dielectric strength: Volume resistivity, minimum ohm-cm^3=10^{15}

10.2 Polyethylene film:
Tensile strength: 1200 psi (8.3 Mpa) minimum
Elongation: 300 percent minimum
Dielectric strength: 800 V/mil. (31.5 um) thickness minimum

10.3 Thickness:
Polyethylene film shall have a minimum thickness of 0.008-in. (8 mil. or 200 um). The minus tolerance on thickness shall not exceed 10 percent of the nominal thickness.

10.4 Tube size or sheet width:
Tube size or sheet width for each pipe diameter shall be as listed below.

Nominal Pipe Diameter (in.)	Minimum Polyethylene Width in. (cm) Flat Tube	Sheet
4	16 (41)	32 (82)
6	20 (51)	40 (102)
8	24 (61)	48 (122)
10	27 (69)	54 (137)
12	30 (76)	60 (152)
14	34 (86)	68 (172)
16	37 (94)	74 (188)
24	41 (104)	82 (208)

PART 11 – SANITARY FORCE MAIN LOCATOR WIRE

Force main locator wire shall be installed with all force main, fittings, and valve installation. The material to be installed for this purpose shall consist of standard electric service wire, a single No. 12 U.L. approved copper wire of the solid type with insulation for 600 volts. Insulated wire for this service shall be provided in standard rolls of not less than five hundred (500) foot lengths.

11.1 Splices: Splices shall only be allowed where accessible. Buried splices will not be allowed.

11.2 Wire Contact: In order to make use of the wire for force main location purposes, a splice point shall be placed adjacent to a valve box location. The wire shall be brought to the ground surface at these locations so a power source can be connected. The wire shall run outside up alongside the valve box, then through a hole into the valve box just below ground level. The splice connector shall be left exposed at the top of the valve box at the wire contact locations. Wire contact points shall be provided at no more than 500-foot intervals, or where approved by the District or their agent, on a case-by-case basis.

Force main locator wire installation shall be in accordance with applicable Articles of these specifications. Locator wire shall be field tested in the presence of District Staff to verify proper tone is achieved prior to acceptance of improvements by the District.

PART 12 – SANITARY SEWER MAIN TRACER TAPE

Tracer tape shall be installed with all force main/gravity sewer. The materials to be installed for this purpose shall consist of three (3) inch wide tape made of bonded layer plastic with a metallic foil core. Tape splices shall be knotted to prevent tensile pressure on the splice. The material to be used for this service shall be “Terra Tape D” as manufactured by the Griffolyn Company of Houston, Texas, or approved equal. The metallic tape shall be colored to contrast with the soil and shall bear an imprint identifying the line below, such as, “Caution, Sewer Main Buried Below”.

Installation of the tracer tape shall be in accordance with applicable Articles of these specifications.

SANITARY SEWER COLLECTION SYSTEM INSTALLATION

PART 1 – GENERAL

1.1 Underground pipe construction shall be in accordance with the recommended practice as outlined by the pipe manufacturer.

1.2 All excavations shall be made to such depths and widths as will give ample room for building all structures, sewers, and appurtenances as detailed on the approved plans.

1.3 Clearing and grubbing the site of work, excavation of earth or other materials, sheeting and bracing, pumping and drainage, backfilling, rough grading, and cleaning up shall all be done as specified. In addition, all work maintaining or replacing existing fences, roadways, drives, lawns or structures disturbed by the work, safety precautions and other miscellaneous general work not specified under specific items is to be included in the work done under this section.

PART 2 - SITE AND WORK PREPARATION

2.1 Prior to starting the various installations, connections, and/or changes as required the contractor shall notify the District and Owner a minimum of twenty-four (24) hours prior to the start of construction. After so doing, the Contractor shall clear the route of all trees, shrubs, and other objects or materials which may directly interfere with the construction. All other utility companies or organizations shall be notified for location of their respective facilities prior to starting any work. All trees, shrubs, bushes, etc., which will not interfere with the construction shall be protected from damage. Work preparations shall include having all necessary material items, equipment, and an adequate labor force at the site in working condition and completely instructed and prepared to perform the work to completion as required.

PART 3 - DRAINAGE

3.1 The Contractor shall control the grading in the vicinity of the pipe trenches so that the surface of the ground will be properly sloped to prevent water from running into the excavated areas. Any water or other liquid wastes which accumulates in the excavated areas shall be promptly removed.

PART 4 - TRENCH EXCAVATION

4.1 Contractor shall perform all excavation necessary for, or incidental to, the proper installation and construction of the work shown and detailed on the drawings, or as directed by the District. No trench shall be backfilled or mains concealed prior to inspection by the District or the District's Representative. Mains concealed prior to inspection shall be excavated and exposed at the Contractor's expense. Excavation shall include the removal of trees, shrubs, paving, and undesirable materials. Excavation shall be done along the lines as staked and indicated on the plans and shall be continuous without improper bends, kinks or flexing of the pipe. Trenches shall be of sufficient width to provide a working space on each side of the materials being installed. During excavation, materials to be used for backfilling shall be stock piled, in an orderly manner, a sufficient distance from the edge of the excavation to avoid overloading which might cause slides of cave-ins, and in such manner as not to interfere with public travel whenever possible. The contractor shall provide all barricades, lights, temporary crossing, warning signs, etc., that may be necessary to protect the public and the work from injury or damage.

4.2 Trenches for sewer main and appurtenances shall be excavated to a sufficient depth to obtain a minimum of thirty-six (36) inches of cover over the top of the pipe, except as otherwise required to make taps and connections to existing mains. The bottom of trenches shall be free from rocks, clods, debris, and all other unsuitable materials, and shall consist of properly shaped earth. The Contractor shall take care not to excavate below grade except to remove undesirable material, or as directed by the District or their agent.

4.3 Pipe Bedding and Encapsulation: All trench installed mains shall have granular material placed to depth four (4) inches below the pipe bottom to six (6) inches above the top of pipe. All granular bedding shall be placed so as to provide a continuous bearing for the barrel of the pipe. Holes of sufficient size shall be excavated to permit ample room for making joints. Granular material shall be per previous sections of these specifications. Granular material shall be compacted to prevent settlement and as required by the project specifications.

4.4 Where rock is encountered in the trenching operation, the excavation shall be carried to a depth of four (4) inches below the pipe bottom depth assuming proper cover as specified under the preceding paragraph. Rock is hereby defined as in any material which cannot be removed by an excavator with an operating

weight of at least 52,600 pounds and a flywheel horsepower of at least 153 horsepower. Where solid rock is encountered and it is necessary to drill and blast same, the Contractor shall provide all suitable equipment and personnel for carrying out the operation in a safe and sensible manner. The Contractor's Insurance shall include specific coverage for this and directly or indirectly related items.

4.5 When encountered, the Contractor shall strip from the solid rock areas all overlying earth in sections and shall then notify the District or their agent for inspection and measurement. The District or their agent may then take levels on the surface of the rock and adjacent ground level, or he may, at his discretion, defer the measurement until after excavation is completed. In any event, the Contractor shall not refill any trench where rock is encountered until told to do so by the District or his agent. The rock volume, using lengths and depths as measured in the field, shall be determined on the basis of using the determined pay width of (1.4 x Pipe I.D. + 12"). The Contractor will not be allowed payment for any rock claimed unless same has been measured as herein provided.'

4.6 Excess materials resulting from the rock excavations shall be spread over or adjacent to the trench area where acceptable or shall be picked up and removed from the site for disposal at a suitable location. It may also be necessary to place a thin layer of earth over the rock backfill areas. This may be hauled in from a stockpile location. This earth layer must be of sufficient depth to support the growth of vegetation. All loose rock and debris shall be thoroughly cleaned up and disposed of. The excavated areas shall be left in a neat, clean, acceptable condition.

PART 5 - HANDLING OF MATERIALS

5.1 All pipe, fittings, valves, manholes and other accessories, shall be unloaded, stored rehandled, and installed by methods and in such a manner as to ensure their final location in a sound and undamaged condition, conforming in all respects to specified requirements. Under no circumstances shall pipe, fittings, valves, manholes, or other accessories, be dropped to the ground, or otherwise subjected to possible damage from impact or shock. Such materials shall be loaded by lifting with machine or hoist, or by skidding. Pipe handled on skidways shall not be skidded or rolled against another pipe. When pipe line materials at the site of the work, each piece shall be unloaded opposite, or as close as possible to the point of installation in order to avoid unnecessary rehandling.

5.2 Under all circumstances, all materials for use shall be handled in a workman-like manner, using the necessary manpower and equipment to perform the task in accordance with the manufacturer's recommendations.

A. Protection of Materials, Coatings, and/or Linings: All materials shall be handled in such manner that neither the coatings nor the linings will be damaged. Hooks for insertion into the ends of the pipes, fittings, valves, manholes, and other accessories, shall have broad, well-padded contact surfaces, and shall be of such design and size that uniform support will be provided. Under most circumstances, damage to outside coatings is repairable, and the necessary repairs shall be properly made prior to installation. Damage to interior linings is not considered repairable, and therefore, the damaged item shall be replaced at the Contractors expense.

B. Handling Materials Into Trench: Proper equipment, tools, facilities, and methods satisfactory to the District or their agent, shall be provided and used by the Contractor for the safe handling of all materials. Fittings, valves, and other accessories shall be carefully lowered into the trench or excavation, piece to protect coatings and linings. Under no circumstances shall any materials be dropped or dumped into the trench.

PART 6 - PIPE LAYING AND TRENCH BACKFILL

6.1 GENERAL

A. Installation shall start at the downstream end of the project and shall proceed upstream. All pipe spigot ends shall face downstream and bell ends shall face upstream. Laying the pipe shall commence immediately after the excavation is started, and the Contractor shall use every possible means to keep the completed pipe installation close behind the trenching. The District or their agent may stop the trenching when in his opinion, the trench is open too far in advance of the pipe laying operation. The Contractor may lay pipe in the best manner adapted to securing speed and good results.

6.2 PIPE JOINTS

A. The Contractor shall have the necessary equipment and tools available for making the joints for the specific materials being used. In accordance with applicable items under the previous Section of these specifications, acceptable joints for the various pipeline and fitting materials are listed as follows:

1. Ductile Iron Pipe: Ring or fluid tight joint with mechanical joint for fittings, valves, and adapters.

2. P.V.C. Pipe: Ring tight joint with necessary transition gaskets for connection to mechanical joint fittings, valves, and adapters.

    a. Pipe Joint Adapters: The Contractor shall provide the necessary adapters for all connection changes from ring-tight, slip, or mechanical joint to flanged joint as and where required.

All pipe spigot ends shall be visibly marked to fully “make-up” the joint. With exception of field cut pipe, all “make-up” marks shall be placed on the pipe at the factory. Field cut pipe shall be marked for full joint depth prior to insertion.

3. Installation: Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, while retaining full mechanical joint deflection during assembly.

    a. Proper actuation of the gripping wedges shall be ensured with torque limiting twist off nuts.

6.3 PIPE CUTTING

A. Cutting of pipe for closure pieces with installation of valves or fittings, or for any other reason, shall be done in a neat and workman-like manner without damage to the pipe or linings. The cutting operation shall leave a smooth cut end at right angles to the longitudinal axis of the pipe. The exterior surface of the cut end shall be beveled, and the interior surface shall be reamed or filed free of all rough edges and protrusions. All pipe cutting shall be done by saw or mechanical pipe cutters of an approved type. Upon completion of the cutting and trimming operation, the pipe end or ends shall be marked for “make-up” depth. Prior to insertion, the pipe shall be thoroughly cleaned of all foreign materials, including filing and cutting debris.

6.4 PIPE ALIGNMENT

A. Gravity mains are intended to be laid straight. Force main deflections from a straight line shall not exceed the manufacturers recommendations for joint deflections. Should the planned or specified alignment require deflections in excess of the maximum recommended for the type of pipe being installed, when using a standard pipe length within the limits of available space, then either shorter pipe sections or additional bends shall be installed.

6.5 EXISTING UTILITIES

A. Existing utilities shall be protected during the construction period. Where necessary, the existing utility shall be removed or temporarily relocated and replaced upon completion of that phase of the work creating this requirement. Under all circumstances, the utility involved and the parties being affected by the disrupted service shall be notified in advance of the proposed operation. All changes and work shall be subject to the approval and acceptance of the utility involved and the District or their agent.

6.6 QUALITY

A. Damaged or unsound pipe, fittings, and accessories of whatever nature shall be rejected and removed from work. All joints shall be made as previously specified. Each piece of pipe and all fittings, valves, etc., shall be checked and cleared of debris prior to being put in place. All gaskets shall be rechecked for operation and bolt tightness prior to installation. All open ends of pipe, fittings, etc., shall be carefully plugged or sealed at the end of each day’s work to prevent entrance of animals, water, and other foreign matter. All excavation shall be made to neat line and grade.

All personnel involved in any way with the work must be made aware of the fact that the work shall result in a first-class, professional job.

6.7 SANITARY MAIN TRACER TAPE INSTALLATION

The Contractor shall furnish all materials and install the sewer main tracer tape as specified in the previous Section of these specifications. The three (3) inch wide detectable tape shall be installed directly above the sewer main locations as the trench backfill progresses, to permit an earth cover of 12 to 18 inches over the tape. The tape material shall be installed in accordance with the manufacturer's recommendations. The tape is to be placed in a manner such that trench backfill settlement will not place an excessive tensile stress on the material.

6.8 SANITARY FORCE MAIN LOCATOR WIRE INSTALLATION

The Contractor shall furnish all materials and install the force main locator wire as specified under the previous Section of these specifications. The No. 12 insulated wire shall be placed under the force main at the bottom of the trench or wrapped around the force main. The wire shall be brought up alongside a valve box. The wire shall be spliced at these locations using a standard plastic or rubberized wire connector. This will permit placing a power source on the wire for both directions in order to use same for locating the force main. The wire shall be wired to the valve box or post to retain its location. At no point will buried splices be allowed. The wire shall be loosely knotted at each splice location to prevent direct stress on the connection. The wire shall be laid slack in the trench so same will not be subject to tensile stress as the trench is backfilled.

Prior to final acceptance by Owner, Contractor shall demonstrate that the locator wire works to the satisfaction of the Owner and/or his representative.

6.9 TRENCH BACKFILL

A. After placing the piping in the trench, the Contractor shall backfill under and around the pipe simultaneously filling and tamping on both sides with sufficient earth to firmly hold the pipe in position. Extreme care must be exercised with the backfill operations to ensure that no sizable stones or rocks come into contact with the pipe surfaces. Pipe bedding shall include a minimum of 4" of 1" granular material below the pipe. After carefully placing and tamping the initial backfill in place to at least six (6) inches over the top of the pipe barrel, the remaining materials may be pushed into the trench. No boulders, broken pavement, or large pieces of blasted rock shall be used in the trench backfill. Any trench improperly bedded or backfilled shall be excavated, examined, and replaced at the Contractor's expense. All non-usable materials shall be picked up and removed from the site to an acceptable disposal location. Upon completion of the initial backfill, the backfill surface shall be neatly mounded to allow for settlement. As the work progresses and settlement occurs, the trenching surface shall continue to be graded and shaped so as to secure a final condition where no further settlement shall occur.

B. In areas where pavement or permanent surfacing is removed and is to be replaced, the entire backfill shall be made using fine crushed stone placed in six (6) inch layers and compacted to a maximum density.

C. Initial clean-up, in accordance with Article 14 shall occur as the trench backfill operation proceeds. Before final acceptance of the work is made, the Contractor shall travel the lines with the District or their agent, and any settlement or unsightly areas shall be repaired or corrected as directed. Upon acceptance, the Contractor shall proceed with the final clean-up, grading, and seeding operation, in accordance with Article 15 this Section of the specifications.

PART 7 – SERVICE LINE WYE INSTALLATION

The Contractor shall furnish all materials and install service connection fittings and service lines as required.

A. Sewer Main Service Line Connection Fittings: Fittings for service line connection to the sanitary sewer main shall be placed where indicated in the field by the District or their agent. All service connection fittings shall be wye or double wye fittings in accordance with Part 2 of Section 02530 of the specifications. All service connection fitting joints shall be watertight and of a quality equal to that of the sanitary main being used.

B. Sewer Lateral Service Line: The Contractor shall furnish all materials and install sewer lateral service lines from connection to the sewer main wye fitting as shown on the plans.

All service lines and wye installed for future connections shall terminate with a rubber faced threaded compression type expanded plug. All service line and fittings shall be in accordance with Part 2 of Section 02530 of the specifications.

PART 8 – MANHOLE INSTALLATION

8.1 BASE

A. Pre-cast manhole base sections shall be set on the prepared sub-grade in proper alignment for connection to the inlet and discharge connections. In the event fill under the base section is required to achieve the proper grade, it shall be made using a 1 inch minus crushed stone fill, fully compacted to sub-grade. Earth fill under pre-cast base sections will not be permitted.

1. Pipe Connections: Sewer main connections to the manhole base shall be made prior to placement of the manhole barrel sections. The pipe to manhole connection shall be made using the rubber gasket installed during the manhole casting process.

8.2 BARREL

A. The manhole barrel shall be set on the pre-cast base. The barrel shall be constructed of pre-cast sections as previously specified.

1. Pre-Cast Sections: The barrel to base joint shall be sealed using the rubber ring provided for this purpose when placing same over a pre-cast base section. The remaining seam shall be sealed using non-shrink grout on the interior and MarMac wrap at exterior joint locations. All remaining barrel joints and top or cone to barrel joint connection, shall be sealed using the rubber gasket and asphaltic-fibre cement application.

All exterior joints shall be sealed with MarMac wrap the entirety of the joint.

An eccentric pre-cast top or cone section shall be placed over the manhole barrel sections. The top to barrel joint seal shall be made as previously specified for pre-cast section joints. All manhole steps shall be in alignment with the vertical wall of the manhole. The top of the cone section shall provide a 24-inch diameter circular opening.

8.3 MANHOLE COMPLETION

A. Upon completion of the manhole barrel construction, all debris shall be removed from the excavated area and disposed of. Following clean up, the excavated area shall be backfilled with clean earth. Care must be exercised to maintain the manhole barrel joints in a scaled condition. The backfill may be carefully jetted with water to achieve initial settlement. Following initial settlement, the top of the manhole cover frame shall then be set in place using the frame lugs to center the frame over the opening. It is intended that the frame to top of cone seal shall be watertight. The manhole cover shall then be put in place. Following placement of the manhole frame and cover, the backfill operation shall proceed to the top of the manhole frame and cover. Manhole acceptance tests shall then be completed prior to any flows through the system. Following acceptance tests, the contractor shall then coat or seal the entirety of the interior of the manhole with OBIC multi-layer coating system. These linings shall be applied to manholes in which pressurized sewer mains discharge and to the two manholes downstream from this discharge point. Lining shall be placed in the wet well of all new lift stations. Additional lining of existing collection system manholes shall be determined by the District, if necessary.

8.4 OBIC LINING OF MANHOLES

8.4.1 PRODUCTS

MANUFACTURERS

A. Subject to compliance with requirements, manufacturers that may be used include:

1. OBIC, LLC.

PROTECTIVE LINING SYSTEM MATERIALS

A. The protective lining system shall be a multi-layer/component protective lining system, OBIC including:

1. Polyurea Adhesion Coating
2. Polymer Surfacer Layer
3. Final Polyurea Armor Layer

LINER SYSTEM ARMOR LAYER

A. 100% solids, no volatile organic compound (VOC), moisture tolerant, elastomeric polyurea coating to provide infiltration and corrosion protection. Material shall be capable of curing properly given the project site conditions and temperatures conforming to the following minimum physical requirements:

Property	Value
Hardness, D-2240	D 48
Tensile strength, D-412	3315 psi
100% Modulus, D-412	1668 psi
200% Modulus, D-412	1960 psi
300% Modulus, D-412	2650 psi
Tear resistance/DIE-C, D-624	417 pli
Ultimate elongation, D-412	395 %
Taber Abrasion, mg loss CS17	15 mg loss
Flexibility, 1/8” mandrel	Pass
ASTM G210-13 SWAT	Pass

LINER SYSTEM SURFACER LAYER

A. 100% solids, no volatile organic compound (VOC), moisture tolerant, elastomeric polyurethane coating to provide infiltration and corrosion protection. Material shall be capable of curing properly given the project site conditions and temperatures conforming to the following minimum physical requirements:

Product Type	Value
Density (ASTM D – 1622	6-8 pcf
Compressive Strength 1”	130-180 psi
Closed Cell Content	> 94%
Water Absorption	< 0.03 lbs/sqft
Maximum Service Temp	180 deg
Viscosity (A side) 72 deg F	675 cps
Viscosity (B side) 72 deg F	200 cps

8.4.2 EXECUTION

SURFACE PREPARATION

A. Conduct surface preparation program to include monitoring of atmosphere for hydrogen sulfide, methane, low oxygen or other gases, approved flow control equipment, and surface preparation equipment.

B. Surface preparation methods may include high pressure water cleaning, hydro blasting, abrasive blasting, grinding, detergent water cleaning and shall be suited to provide a surface compatible for installation of the liner system.

C. Surface preparation method shall produce a clean, abraded and sound surface with no evidence of laitance, loose concrete, brick or mortar, contaminants or debris, and shall display a surface profile suitable for application of liner system.

D. After the defects in the structure are identified, repair all leaks with a chemical or hydraulic sealant designed for use in field sealing of ground water. Severe cracks shall be “repaired with a urethane-based chemical” sealant. Product to be utilized shall be as approved by owner/engineer prior to

installation. Repairs to exposed rebar, defective pipe penetrations or inverts, etc. shall be repaired utilizing non-shrink grout or approved alternative method.

REPAIR MATERIALS

A. Repair materials shall be used to fill voids, structurally reinforce and/or rebuild surfaces. Repair materials shall be compatible with the polyurea coating and shall be applied in accordance with the manufacturer's recommendations.

B. Subject to compliance with the polyurea coating manufacturer's requirements, the following products shall be acceptable as compatible repair base coat materials for polyurea top coating:

1. A hydraulic cement and/or plug shall be used to stop active infiltration. The hydraulic cement and plug shall be suitable for the polyurea top coating and shall be approved by the polyurea coating manufacturer.

2. Hydrophobic and/or Hydrophilic polyurethane chemical grouts used to stop active infiltration. The chemical grouts shall be suitable for the polyurea top coating and shall be approved by the polyurea coating manufacturer.

MATERIAL INSTALLATION

A. Application procedures shall conform to recommendations of the manufacturer, including materials handling, mixing, environmental controls during application, safety and spray equipment.

B. Spray equipment shall be specifically designed to accurately ratio and apply the liner system.

C. Application of multi-layer/component liner system shall be in strict accordance with manufacturer's recommendation. Final installation shall be a minimum of ½" (500 mils).

1. Adhesion Layer (not intended to fill small voids)
2. Surfacer Layer (intended to fill voids, bug holes)
3. Armor Layer

8.4.3 INSPECTION

A. Final liner system shall be completely free of pinholes or voids. Liner thickness shall be the minimum value as described herein (500 mils).

B. Due to the fast gel and set time of the material, thickness of the application can be verified by awl point depth checks into the surfacer component and physical removal of a small area of the polyurea material. Repair of the test areas to be done immediately after the test.

C. High Voltage Holiday Detection may be used to inspect for pinholes or breaches in the liner system installation.

D. Visual inspection shall be made by the Owner/Engineer. Any deficiencies in the finished liner system shall be marked and repaired according to the procedures set forth by Manufacturer.

E. The manhole/wet well may be returned to full operational service after the final inspection has taken place.

All backfill operations shall be in accordance with the applicable Articles of the specifications. All manhole construction, frame and cover, etc., shall be in accordance with the plan details and notations.

PART 9 – LIFT STATION INSTALLATION

Contact District Engineer for site specific requirements. Typical detail included for budgeting and planning.

PART 10 – GRINDER PUMP STATION INSTALLATION

Contact District Engineer for site specific requirements.

PART 11 – WORK ADJACENT TO AND/OR CROSSING STATE OF COUNTY HIGHWAYS

11.1 GENERAL

A. All work to be performed within the right-of-way limits of the State and/or County Highways shall be performed in strict accordance with the Highway Department requirements. The Contractor shall obtain the necessary permits for all work prior to starting any construction. All permits must be displayed as required. The Contractor shall comply with all requirements such as; signals, flagmen, and watchmen; performance of work in such a manner so as not to interfere with traffic, highway entrances, highway maintenance, highway drainage, etc., and methods of placing materials, backfill compaction, and all such other requirements, which may differ from or may be in addition to those specified for work other than that within the highway right-of-ways limits.

11.2 HIGHWAY/ROAD CROSSINGS

A. Highway/Road crossings shall be constructed in accordance with all permit requirements. The Contractor will be held responsible for any and all expense incurred by the governing road agency in protecting the roadway/highway while construction is in progress, or as a result of said construction. The contractor will also be held responsible for all damages to the roadway/highway due to operations during construction of the crossings, including replacement of damaged pavement. Encasement shall extend from ditch line to ditch line, toe of slope to toe of slope of all private/public roadway crossings.

1. Boring and Jacking: The crossing shall be machine bored with simultaneous installation of the encasement. Boring without the concurrent installation of the encasement tube will not be permitted. All joints of the encasement tube shall be welded as specified and the encasement tube shall extend to the required dimensions.
2. Auger Crossing: CTS HDPE sewer main two (2) inches in diameter and smaller shall be placed in auger-type crossings where shown and as detailed on the plans. Pipe joints will not be permitted within the length of the crossing.
3. Open Trench Encasement: Sewer main encasement may be placed in open trench where allowed or permitted. Encasement shall be installed to grade as shown on the plan profile sections. It is recommended that the cut installations be coordinated with the road construction to rough sub-grade. The entire encasement length shall be excavated to subgrade. The encasement pipe shall then be placed over 4 to 6 inches of crushed stone. Following placement, the entire trench shall be backfilled with minus crushed stone compacted in 6 to 8-inch lifts to the road sub-grade level or to the top of the trench.
4. Directional Bore: The crossing may be directionally bored to install PVC restrained-joint casing pipe as previously specified, and as shown on the approved plans.
5. All work shall comply with Section 734 of MoDOT Specifications.
6. Backfill: Following completion of the machine bored crossing, all bore pit or other required excavation shall be suitably backfilled to grade. All debris, of whatever nature, shall be picked up and removed from the site. After clean-up, the disturbed area shall be smoothed to grade, seeded, and covered with straw. The entire work area shall be left in an orderly and acceptable condition.

PART 12 – TESTING OF GRAVITY SEWERS

The extent of testing shall be at the discretion of the owner and engineer and paid for by the contractor.

12.1 GENERAL

After construction and backfilling are completed and before any services are connected the sewers, the completed lines shall be tested for leaks and visually checked for straightness of line and cracked pipe. If any deficiencies in line or grade are found which will be detrimental to the proper functioning of the sewer, the deficiencies shall be corrected. Any damaged or cracked pipe shall be excavated and re-laid in a manner satisfactory to the Owner. Any section of sewer, which is found to be leaking in excess of the allowable quantity, shall be repaired.

12.2 ACCEPTANCE TESTS

A. Each reach of sewer failing to meet the requirements of the following shall be repaired to the satisfaction of the Owner.

1. Upon completion of the sewers, acceptance tests will be conducted by the Contractor in the presence of the District or their agent to determine the acceptability of the sewers. The testing schedule shall be submitted to the District or their agent by the Contractor prior to testing. The Contractor shall furnish suitable test equipment, materials and manpower to conduct the test.

2. All completed pipe sewers shall be subject to an exfiltration test. The sewer pipe shall sustain a maximum limit of 100 gallons per inch of diameter per day per mile. The exfiltration test shall cover a period of at least four continuous and connective hours. For purposes of determining maximum allowable leakage, manholes shall be considered a section of 48-inch pipe.

3. No ground water in an amount greater than that allowed and specified herein for the exfiltration test shall be permitted.

4. Any completed pipe sewers not conforming to the tests herein specified or conforming to all requirements of the specifications, plans and profiles, or subject to any irregularity of construction shall be removed and replaced.

5. The Contractor shall cooperate fully with the District or their agent for the inspection and testing of the completed work.

6. Stoppers and/or plugs for the various sizes of pipe shall be furnished by the Contractor for use in the tests and personnel shall be made available by the Contractor for aid in conducting the tests herein specified.

7. As an alternate to the exfiltration test, a low-pressure air test may be conducted after backfilling and before replacing pavement. The equipment shall be provided, and tests shall be conducted by the Contractor in the presence of the District or their agent.

8. The Contractor may desire to make an air test prior to backfill for his own purpose, but “Acceptance Test” shall be conducted after backfilling.

9. All wyes, tees or ends of lateral or service stubs shall be suitably capped to withstand the internal pressure during testing. Such caps shall be easily removable for future connections or extensions.

10. After each manhole-to-manhole section of line has been backfilled and cleaned, the ends shall be plugged with pneumatic plugs. These plugs shall be designed such that they will hold against line test pressure without requiring blocking or bracing. All pneumatic plugs shall pass a qualifying test in the presence of the District or their agent before actual line testing as follows: One length of pipe shall be laid on the ground and sealed at both ends with the pneumatic plugs being tested. Air shall be introduced into the pipe until the pipe pressure reaches 15 psi. The pneumatic plugs shall hold against this pressure without bracing and movement of the plugs.

11. Air for inflation of the triple connection pneumatic plug shall be supplied through a factory-equipped control panel. There shall be three hose connections from the control panel to the triple connection pneumatic plug. One hose shall be used only for inflation of the pneumatic plug. The second hose shall be used for continuously reading the air pressure rise in the sealed line.

12. There shall be a 3 ½” diameter, 0-30 psig gauge mounted on the control panel for reading the internal pressure of the line being tested. Calibrations from the o-10 psig range shall be in tenths of pounds (not ounces) and this 0-10 portion shall cover 90% of the completed dial range.

13. Low pressure air shall be introduced into the sealed line until the internal air pressure reaches 4.0 psig greater than the average back pressure of any ground water pressures that may be over the pipe. At

least two minutes shall be allowed for the air pressure to stabilize. After the stabilization period, the third hose shall be quickly disconnected from the control panel.

14. The portion of line being tested shall be accepted if the portion under test does not lose air at a rate greater than 0.0015 cfm per square foot of internal pipe surface when tested at an average pressure of 3.0 psig greater than any back pressure exerted by ground water that may be over the pipe at the time of the test.

15. The above requirement shall be accomplished by performing the test as follows. The time required in minutes for the pressure to decrease from 3.5 to 2.5 psig (greater than the average back pressure of any ground water that may be over the pipe) shall not be less than the time shown for the given diameters in the following table (See Table 3 this Section):

TABLE 3

PIPE DIAMETER INCHES	MINIMUM TIME MN: SEC	LENGTH FOR MINIMUM TIME FEET	TIME FOR LONGER LENGTHS SECONDS
4	3:46	597	3.380 L
6	5:40	398	0.654 L
8	7:34	298	1.520 L
10	9:25	239	2.374 L
12	11:20	189	3.418 L
15	14:10	159	5.342 L
18	17:00	133	7.692 L
21	19:50	114	10.470 L
24	22:40	99	13.574 L
27	25:30	88	17.306 L
30	28:20	80	21.366 L
33	31:10	72	25.852 L
36	34:00	66	30.768

16. In areas where ground water is known to exist, the Contractor shall install a ½" diameter capped pipe nipple, approximately 10 inches long, through the manhole wall on top of on one of the sewer lines entering the manhole. This shall be done at the time the sewer line is installed. Immediately prior to the performance of the line acceptance test, the ground water level shall be determined by removing the pipe cap, blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to the pipe nipple. The hose shall be held vertically and a measurement of the height in feet of water shall be taken after the water stops rising in this plastic tube. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to readings.

17. If the installation fails to meet this requirement, the Contractor shall determine at his own expense the source of the leakage. He shall repair or replace all defective materials and/or workmanship. The use of sewer scaling materials and methods shall not be used or accepted.

18. There shall be no substitute for good construction. The replacement of any pipes, pipe or fraction thereof shall require the end connections to be made with factory manufactured pieces having flexible gasketed joints to fit intended use. The use of half bell pipe and/or concrete collar will not be acceptable. Test shall be repeated as often as necessary until the installation meets the requirements of the acceptance test.

19. Pipe Deflection: Each segment of P.V.C. sewer main shall be tested for deflection. The test shall consist of pulling a mandrel through each segment of P.V.C. pipe. The mandrel shall be an object having a cross-section, or same shall be a ball, having a diameter equal to 95% of the nominal pipe inside diameter. A steel cable of adequate known length and strength characteristics, shall be used to pull the mandrel through the piping. In the event of a failure, the failure location shall be found by measurement, and the piping shall be repaired or replaced as required. After failure correction, the segment shall be re-tested. This process shall be repeated as often as necessary.

It is recommended that the test for deflection precedes the test for infiltration and exfiltration. The Contractor shall furnish all equipment as required to perform all testing as specified. All tests shall be conducted in the presence of the District or their agent.

20. After completion of aforementioned testing, each manhole shall be subjected to any exfiltration test. The manhole to be tested shall be isolated from the sewer lines by installing pneumatic plugs in the sewer lines using the same procedure as for air testing, except that the plugs shall be installed in such a manner that there is a clear distance of at least 18" between the inside face of the manhole and the face of the plug. The manhole shall be tested by one of the two methods discussed below.

12.3 WATER TEST

The manhole shall then be filled completely with water. Depth of water shall be at least 3' above ground water. A liquid level measurement shall be made and recorded after initial filling and 15 and 30 minutes thereafter. The test is acceptable when the water loss observed is less than 0.1 gallon/foot diameter/foot head/hour. Addition of water during the testing shall not be allowed.

12.4 VACUUM TEST

All lift holes and any pipes entering the manhole are to be plugged. A vacuum will be drawn, and the vacuum drop over a specified time period is used to determine the acceptability of the manhole. The values recorded are applicable only to the manhole being tested and at the time of testing.

The test results will be greatly affected by the preparation of the manhole. All lift holes shall be plugged completely. All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.

A. Procedure

1. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.

2. A vacuum of 10 in. of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 in. of mercury.

3. The manhole shall pass if the time for the vacuum reading to drop from 10 in. of mercury to 9 in. of mercury meets or exceeds the values indicated in Table 1.
4. If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained.

Minimum Test Times for Various Manhole Diameters – Vacuum Test – Table 1

Depth (ft)	**Diameter (Inches)**								
	30	33	36	42	48	54	60	66	72
	Times (Seconds)								
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	48	51	57
16	22	24	30	34	40	45	52	58	67
18	25	27	32	35	45	52	58	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	45	55	54	72	79	89
24	33	36	42	51	59	64	78	87	97
26	38	39	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

21. All sewer pipes shall be flushed to remove any debris, sand or grit from the completed sewers prior to being placed in service. The Contractor shall flush and pump or remove all water from the flushing process.

22. Each section of the sewer line between manholes is required to be straight and uniformly graded. Each section will be lamped in the presence of the District or their agent.

PART 13 – TESTING OF FORCE MAINS

13.1 General: Sufficient backfill shall be placed prior to fillings with water and field testing to prevent lifting of the pipe. When local conditions require that the trenches be backfilled immediately after the pipe has been laid, the testing may be carried out after backfilling has been completed.

At least seven (7) days shall elapse after the last concrete thrust blocking has been cast with normal (Type 1) Portland cement. This elapsed time may be reduced to three (3) days with the use of high-early strength (Type 111) Portland cement.

13.2 Procedure: The following procedure is for the pressure test. Each section of the pipeline shall be slowly filled with water and all air expelled by means of taps at high points. The specified test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Owner. The test pressure shall be maintained for the specified time during which all exposed pipe, fittings, valves, and hydrants shall be carefully examined. All defective elements shall be repaired or removed and replaced and the test repeated until all visible leakage has been stopped and the allowable pressure requirements have been met.

13.3 Pressure Test: The Contractor shall furnish the gauges and measuring device for the pressure test, pump, pipe, connections and all other necessary apparatus, and shall furnish the necessary assistance to conduct the test. The duration of each pressure test shall be two (2) hours and during the test the main shall be subjected to the pressure specified by the District or their agent. Allowable pressure drop during the two (2) hour test shall be limited to 3% of the test pressure.

PART 14 – INITIAL CLEAN UP, GRADING, AND REPLACEMENT

The Contractor shall provide the necessary labor and equipment to permit initial clean up as the sewer main is being installed. Immediately following trench backfill, all areas disturbed by excavation shall be graded to conform to the adjacent ground levels. Earth shall be neatly mounded over the trench location. All debris, of whatever nature, due to the sewer main and service installation, shall be picked up and disposed of. All walks, driveways, roads, streets, etc., shall be replaced to original condition.

PART 15 – FINAL CLEAN UP, FINISH GRADING, SEEDING, AND STRAW

Following completion of the various routes and initial trench settlement, the Contractor shall go over the routes and clean-up all remaining debris. Following completion of the final clean up, all areas in any way disturbed by the installation shall be graded to conform to the adjacent ground areas. After final grading, the graded areas shall be seeded and covered with straw. In areas of rock excavation, it will be necessary to place a four-inch layer of earth over the exposed areas to form a seed bed for vegetation. The earth shall be applied as part of the final grading operation.

PART 16 – GUARANTEE

The Contractor shall guarantee all materials and workmanship in any way involved with this project for a period of one year from the date of final acceptance. Date of final acceptance is hereby defined as being the date on which the Board of Directors accepts the improvements.

END OF SECTION 02530