SECTION 333113.01 – PUBLIC SANITARY UTILITY SEWERAGE PIPING AND ACCESSORIES

Scope:
This section describes products to be incorporated into gravity sewers and accessories and requirements for installation and use of these items. The Contractor shall furnish all labor, equipment and materials necessary to fulfill the requirements of these specifications. All products and work shall be performed in accordance with the latest revisions of applicable American Society for Testing and Materials (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), Recommended Standards for Wastewater Facilities (Ten States Standards, 1997 Edition), or other recognized standards.

Submittals:
Complete shop drawings and manufacturer's data shall be submitted to the Owner, submittals shall be in electronic format if requested.

Products:
This section of the specifications covers the requirements for gravity sewer mains, manholes and accessories. Gravity sewer mains shall be ductile iron (DI) or polyvinyl chloride (PVC) pipe furnished in accordance with the requirements in this section.

A. **Ductile Iron (DI) Sewer Pipe and Fittings**: Pipe shall be centrifugally cast and shall conform to ANSI Specification A 21.51 (AWWA C 110) as amended to date, with mechanical or push-on joints and laying lengths of at least 18 feet. Pipe sizes 4" through 12" shall be standard pressure Class 350, and pipe sizes greater than 12" shall be pressure Class 250 unless otherwise indicated herein or on the Drawings. All pipe and fittings must be manufactured in the United States of America.

(1) Fittings: Fittings shall be cast from gray or ductile iron and shall conform to ANSI Specifications A 21.10 (AWWA C 110) as amended to date. All fittings shall have standard mechanical or push-on joints. Fittings for size 4-inch through 12-inch shall be Class 250 for Gray Iron and Class 350 for Ductile Iron. Fittings for size 14-inch through 48-inch shall be Class 150 for Gray Iron and Class 250 for Ductile Iron. Either Gray Iron or Ductile Iron fittings will be permissible unless otherwise specified or shown on the Drawings.

(2) Lining and Coating: Pipe and fittings shall be cement-lined (standard thickness) inside and bituminous coated outside, in accordance with the applicable provisions of ANSI Specification A 21.4 (AWWA C 104) and, ANSI A 21.51 (AWWA C 151), as amended to date. The inside cement lining shall be treated with a bitiminous seal coat.

(3) Weights and Marking: Weights of pipe and fittings shall conform strictly to the requirements of ANSI Specifications. The class designations for the various classes of pipe and fittings shall be cast onto fittings in raised numerals, and cast or stamped on the outside of each joint of pipe and each fitting after the exterior coating has hardened.

(4) Certification: The manufacturer of iron pipe and fittings shall furnish the Owner with a certified report stating that inspection and specified tests have been made and that the results thereof comply with the applicable ANSI Specifications for each.

(5) Quality and Inspection: Latitudes in workmanship and finish allowed by ASTM notwithstanding, all pipe shall have smooth exterior and interior surfaces; be first quality, be free from cracks, blisters, and other imperfections, and be true to theoretical shapes and forms throughout each length. Pipe shall be subject to inspection by the Owner at the pipe plant, trench, and other points of delivery for the purpose of culling and rejecting pipe, independent of laboratory tests, which does not conform to the requirements of this Section. Pipe which does not conform will be so

marked by the Owner, and shall not be used in the work. On-the-job repairing of rejected pipe will not be permitted.

(6) Experience of Manufacturer: The pipe manufacturer shall submit evidence, if requested by the Owner, of having consistently produced pipe and joints of the quality specified herein, and which have exhibited satisfactory performance results in service over a period of not fewer than five years. The pipe manufacturer and the pipe manufacturing process shall be subject to approval by the Owner.

B. **Polyvinyl Chloride (PVC) Sewer Pipe and Fittings:** Polyvinyl chloride (PVC) sewer pipe shall be bell and spigot pipe, shall be in lengths not exceeding 20 feet laying lengths and shall have minimum wall thickness conforming to ASTM D 3034 under the classification for DR 26 pipe, as amended to date. All pipe and fittings must be manufactured in the United States of America.

Polyvinyl chloride (PVC) sewer pipe fittings shall be bell and spigot or bell and plain end and shall conform to ASTM D 3034, as amended to date.

(1) Markings : PVC pipe shall be marked at intervals of 5 feet or less with the following information, manufacturer's name or trademark, plant code, date of manufacturer, nominal pipe size, PVC cell classification, the legend "Type PSM DR 26 PVC Sewer Pipe" and ASTM designation D 3034.

(2) Fittings shall be marked with the following information: manufacturer's name or trademark, nominal size, designations PVC and PSM and ASTM designation D 3034.

(3) All markings shall remain legible during normal handling, storage and installation.

(4) Certification : The Contractor shall furnish the Owner with a written statement from the manufacturer that all pipe and fittings furnished have been sampled, tested and inspected in accordance with ASTM D 3034, as amended to date. Each certification so furnished shall be signed by an authorized agent of the manufacturer. All manufacturers

(5) Joints : All pipes shall have elastomeric joints with an integral belled gasket coupler. Rubber gaskets shall comply with the physical requirements specified in the latest revision of ASTM F 477, as amended to date. Joints shall meet the requirements specified in ASTM D 3212, as amended to date.

(6) Quality and Inspection: Latitudes in workmanship and finish allowed by ASTM notwithstanding, all pipe shall have smooth exterior and interior surfaces; be first quality, be free from cracks, blisters, and other imperfections, and be true to theoretical shapes and forms throughout each length. Pipe shall be subject to inspection by the Owner at the pipe plant, trench, and other points of delivery for the purpose of culling and rejecting pipe, independent of laboratory tests, which does not conform to the requirements of this Section. Pipe which does not conform will be so marked by the Owner, and shall not be used in the work. On-the-job repairing of rejected pipe will not be permitted.

(7) Experience of Manufacturer: The pipe manufacturer shall submit evidence, if requested by the Owner, of having consistently produced pipe and joints of the quality specified herein, and which have exhibited satisfactory performance results in service over a period of not fewer than five years. The pipe manufacturer and the pipe manufacturing process shall be subject to approval by the Owner.

C. **Steel Pipe for Ditch or Creek Crossings**:

(1) Pipe: Pipe shall conform to AWWA Specifications C-202 as amended to date for electrically welded or seamless steel pipe. The pipe shall have a minimum wall thickness of 0.375 inches and shall be furnished in forty foot (40') joints. All welding shall be performed by certified welders.
(2) Lining and Casing: Pipe and fittings shall be cement-lined (standard thickness) inside and bituminous coated outside, in accordance with the applicable provisions of ANSI Specification A 214 (AWWA C 104) and ANSI A 21.51 (AWWA C 151), as amended to date. The inside cement lining shall be treated with a bituminous seal coat.
(3) Certification: The manufacturer of steel pipe and fittings shall furnish the Owner with certified reports stating that inspection and specified tests have been made and that the results thereof comply with the applicable ANSI specifications.

D. **Precast Concrete Manholes:** Precast concrete manholes shall consist of precast reinforced concrete riser sections, eccentric top section unless shown as concentric in the Drawings and a base section conforming to Typical Details shown on Detail Drawings. Precast manhole sections shall be manufactured in accordance with ASTM C 478, as amended to date, and these specifications. Concrete shall have a minimum compressive strength of 4,000 psi when tested in accordance with ASTM C 39, as amended to date. Steel reinforcement shall be as specified in ASTM C 478, as amended to date. Wall and bottom sections shall have a minimum thickness of five inches (5").

(1) Base Sections: Base sections for precast concrete manholes shall have a bottom poured monolithically with the walls. Base sections shall be furnished with inside diameters of 4, 5, and 6 feet as required. Base sections shall be furnished with a minimum height of 24 inches for pipes having a diameter of 8, 10, or 12 inches and a minimum height of 36 inches for pipes having a diameter of 15 or 18 inches. Minimum height for 5 or 6 foot inside diameters shall be 48 inches regardless of pipe size. Base sections with 5 or 6 foot inside diameters shall be reduced to 4 foot inside diameter by means of an adapter ring or transition top. The openings in the base section for the accommodation of the pipe shall be cast to closely conform to job conditions and shall provide a minimum clearance of three inches (3") between the inside bottom of the base and outside bottom of the pipe barrel.
(2) Riser Sections: The riser sections shall be furnished in a minimum of six inch (6") increments and shall be four feet (4') in diameter with, (a) tongue and groove joint to be sealed with 2complete runs of approved butyl rubber or bitumastic material, similar to "E-Z Stik" as manufactured by Concrete Supply Company or (b) O-ring gasket type joint conforming to ASTM C 443, as amended to date. The gasket joint shall be thoroughly cleaned of all loose materials and brushed with an approved Epoxy to give a smooth surface free of any honeycomb. All manhole joints must be externally sealed with a tar epoxy and plastic seal as shown in the standard details.
(3) Alteration to Manholes: All alterations to manholes must be done using a coring machine and boots for the pipes unless approved by the engineer and owner. In the event that the manhole has to be altered after delivery to job site the Contractor may, with permission of the Owner, connect the pipe to the manhole with a collar of mortar and brick. The opening between the pipe and manhole shall have a minimum clearance of one inch (1") and shall be filled from the inside and outside of the manhole with a non-shrink grout.
(4) Repaired and Patched Sections: Repaired and patched sections will not be acceptable unless each individual section so repaired or patched shall first have been inspected and approved by the Owner, for repair and patching at the manhole plant. Repairs to and patching of "O"-ring grooves and shoulders will not be permitted.
(5) Absorption: Absorption shall not exceed 9 percent when determined in accordance with ASTM C 497, as amended to date.

(6) Testing and Stamping: An inspection, by an independent testing laboratory approved by the Owner, of the manufacturer's plant and product will be required to assure conformity of the precast manholes to these Specifications, and the minimum requirements of ASTM C 478, as amended to date. Each section of precast concrete manhole shall be stamped with the laboratory's stamp. Each stamped section shall indicate the laboratory's configuration that it was accepted in accordance with applicable ASTM Specifications. A copy of such report will be furnished the Owner with submittal of shop drawings for approval. Job site inspection shall be visual for shape, uniformity, and density.

E. **Miscellaneous Iron and Steel:** Miscellaneous iron and steel for straps, brackets and related items shall be as shown and called for on the Drawings. Bolts and nuts shall be of the best quality high strength steel, unless otherwise shown on Drawings. Bolts and nuts in general shall be United States standard dimension. All anchor bolts exposed to the weather shall be of stainless steel, Type 316, unless otherwise specified. Anchor bolts in general shall be placed in forms prior to pouring concrete. When concrete anchors must be used, they shall be chemical anchors, Hilti "HY 150" or Hilti "Kwik Bolt" mechanical anchors, or equal. Welding under these Specifications may be done by the MIG, TIG or "Electrode" Method in accordance with AWS-ASTM E 6012, as amended to date, (Electrode Method only).

F. **Iron Castings:** Castings shall be of gray-iron conforming to ASTM A 48, as amended to date. Manhole and step castings shall be as shown on the Detail Drawings unless otherwise specified. Castings shall be tough, close-grained and smooth, free from blow holes, blisters, shrinkage stains, cracks, cold shots and like defects. No plugging of defective castings will be permitted. Castings shall be made accurately to dimensions shown on the Drawings or ordered and shall be planed or ground where necessary, whether marked or not, to secure perfectly flat bearing surfaces. Allowance shall be made in the patterns so that the specified thickness of metal will not be reduced. No casting will be accepted, the weight of which is less than the theoretical weight, based on required dimensions, by more than five percent (5%).

G. **Painting:** Straps, brackets and related items shall be primed in the shop with one (1) coat of Inertol Rust inhibitive Primer 621 FDA, 1.5 dry mil thickness. Coating in the field will be with one (1) coat of Inertol No. 49 Thick, 5.0 dry mil thickness. Manhole frames, covers and steps shall be given one coat of an asphaltic or bituminous paint which results in a smooth and tough well-bonded coating. No separate payment will be made for the above work. The cost of such work, and all cost incidental thereto, shall be included in the unit prices bid for the item to which the work pertains.

H. **Polyethylene Encasement:** Polyethylene encasement shall be 60 mil polyethylene sheet and shall be used to wrap the sewer pipe where required in the drawings or as directed by the owner. At a minimum all metallic sewer piping must be encased when located within 50 feet of any natural gas pipelines, encasement must be continuous for 50 feet either side of all crossings.

Implementation:

A. **Unloading:** Equipment and facilities for unloading, hauling, distributing and storing materials shall be furnished by the Contractor and shall at all times be available for use in unloading materials. Delays in unloading railroad cars, unloading trucks, or hauling from freight terminal which incur demurrage, truck waiting charges or terminal charges shall be at the expense of the Contractor.

B. **Handling:** Pipe, fittings and other material shall be carefully handled so as to prevent breaking and/or damage. Pipe may be unloaded individually by hand but shall not be unloaded by rolling or dropping off of trucks or cars. Preferred unloading is in units using

mechanical equipment, such as fork lifts, cherry pickers or front end loaders with forks. If fork lift equipment is not available units may be unloaded with use of spreader bar on top and nylon strips or cables (cushioned with rubber hose sleeve) looped under the unit.

C. **Distributing:** Materials shall be distributed and placed so as to least interfere with traffic. No street or roadway may be closed without first obtaining permission from the proper authorities. The Contractor shall furnish and maintain proper warning signs and obstruction lights for protection of traffic along highways, streets, and roadways upon which material is disturbed. No distributed material shall be placed in drainage ditches.

D. **Storage:** All pipe, fittings and other materials which cannot be distributed along the route of the work shall be stored for subsequent use when needed. The Contractor shall make his own arrangements for the use of storage areas; except that, with permission, he may make reasonable use of the Owner's storage yards. All pipe must be stockpiled on level ground. Timbers must be placed under the pipe for a base and to prevent dirt and debris from washing into the pipe. No separate payment shall be made for the above work.

E. **Location and Grade:** Where new sewer lines are to be constructed, the line and grade of the sewer, and the position of manholes and other structures, will be given by the Owner or Owner. The grade line shown and specified means the invert of the pipe. The price for trenching shall include the trench for the depth below the grade line necessary to lay the sewer to this grade, but measurements for payment will be made only to the grade line. Subsidiary lines and grades shall be laid out by the Contractor from the controlling lines and benchmarks established by the Owner, or from measurements shown. All lines and grades shall be subject to checking by the Owner, but that checking shall in no way relieve the Contractor from responsibility for correctness. The Contractor shall provide such stakes, materials, labor and assistance as the Owner may require in laying-out work, establishing benchmarks, and checking and measuring the work.

F. All gravity sewer lines must meet minimum grade requirements. These requirements are listed in the following chart:

Pipe Diameter	Minimum Grade
8	0.50%
10	0.30%
12	0.22%
15	0.16%
18	0.12%
21	0.10%
24	0.08%
30	0.06%

G. For any sewers exceeding an 18.8% slope, concrete anchor blocks are required in accordance with the following:

Slope (%)	Distance Between Anchors (LF)
18.8 to 35%	Not over 36 LF
35 to 50%	Not over 24 LF
> 50%	Not over 16 LF

The anchor blocks must extend a minimum of 19 inches below the main and 6 inches above the main. Crushed stone is also required as a bedding for the sewer pipe.

H. **Order of Work:** The Owner reserves the right to accept and use portions of the work when it is considered to be in the public's interest to do so; the Owner shall have the authority to establish the order in which the lines shall be worked.

I. **Inspection:** All work done and materials furnished shall be subject to inspection by the Owner or his authorized representative. Improper work shall be reconstructed and materials which do not conform to the requirements of this Section shall be removed from the work upon notice being received from the Owner of the rejection of those materials. The Owner shall have the right to mark rejected materials and/or the Contractor shall segregate said materials to distinguish them as such.

J. **Organization of Work**: The Contractor shall so organize the work that backfilling and cleanup shall closely follow pipe laying operations and manhole construction. In general, not more than one block of a street or roadway shall be closed for construction at any one time. Before proceeding with trenching operations in a succeeding block, the preceding section shall be backfilled, cleanup completed and the street opened to traffic. For work outside the streets and roadways, backfilling and windrowing, in accordance with the provisions of "General Backfilling" paragraph of Section 312333 Trench Excavation and Backfill shall be performed in such a manner that not more than five hundred (500') feet of trench shall remain open at any one time. Failure on the part of the Contractor to comply with the above provisions in a reasonable manner, in the opinion of the Owner, shall be sufficient cause for the Owner to order a temporary shut-down of further trenching and pipe laying operations until the provisions have been met.

K. **Bedding and Laying of Gravity Sewer Pipe:** All sewer pipes shall be laid upgrade, spigots shall point downgrade. The pipe and specials shall be laid in the trench so that, after the sewer is completed, the invert surface shall conform accurately to the grades and alignment fixed or given by the Owner. The interior of all pipes shall be carefully freed of all dirt and superfluous material of every description, as pipe laying proceeds. Defective joints discovered after laying shall be repaired and made tight. Defective pipe shall be removed and proper replacement made. Ductile iron pipe and PVC pipe for gravity sewers shall be laid as specified using the following type of bedding required for the depth cover for the various sizes of pipe to be installed.

(1) Flat Bottom Trench: New sewer pipe shall not be installed in a flat bottom trench.

(2) Selected Materials: Pipe shall be installed using Type 3, Type 4, or Type 5 trench conditions. A Type 3 trench has a base with a minimum of 4 inches of loose soil with backfill lightly consolidated to top of pipe. A Type 4 trench has a base with a minimum 4 inches of sand, gravel, or crushed stone to a depth of 1/8 the pipe diameter and backfill must be compacted to top of pipe. A Type 5 trench has a base with a minimum of 4 inches of compacted granular material bedded to centerline of pipe with backfill of compacted granular or select material to top of pipe. Backfill shall be as specified in the 'Selected Backfilling' and 'General Backfilling' paragraphs of specification Section 312333.

(3) Cover: Maximum depth of cover for DR 26 PVC is 15 feet (regardless of size) and minimum allowable bedding condition is Type 5 with Class 1 "Select Backfilling" material for all depths of cover. Maximum depth of cover and bedding requirements for ductile iron pipe of the various classes and sizes to be installed are as follows:

Pipe Size (Inches)	Pressure Class	Nominal Thickness (In.)	Laying Condition Maximum Depth of Cover – ft.		
			Type 3	Type 4	Type 5
4	350	0.25	69	85	100+
6	350	0.25	37	47	65

8	350	0.25	25	34	50
10	350	0.26	19	28	45
12	350	0.28	19	28	44
14	250	0.28	15	23	36
	300	0.30	17	26	42
	350	0.31	19	27	44
16	250	0.30	15	24	34
	300	0.32	17	26	39
	350	0.34	20	28	44
18	250	0.31	14	22	31
	300	0.34	17	26	36
	250	0.36	19	28	41
20	250	0.33	14	22	30
	300	0.36	17	26	35
	350	0.38	19	28	38
24	200	0.33	12	17	25
	250	0.37	15	20	29
	300	0.40	17	24	32
	350	0.43	19	28	37
30	150	0.34	9	14	22
	200	0.38	12	16	24
	250	0.42	15	19	27
	300	0.45	16	21	29
	350	0.49	19	25	33

L. **Jointing of Ductile Iron Pipe with Mechanical or Push-on Joints**: Proper and suitable tools and equipment shall be used for the safe and convenient handling and laying of ductile iron pipe. Care shall be taken to prevent damage to the exterior coating and interior cement lining. All pipe shall be carefully examined for cracks and other defects before laying. If any pipe or fitting is discovered to be defective after having been laid, it shall be removed and replaced with sound material at the expense of the Contractor. Whenever pipe is required to be cut, the cutting shall be done by skilled workmen using an abrasive wheel cutter. Use of a cold chisel or oxyacetylene torch will not be permitted.

(1) Mechanical Joints: Mechanical joints shall be made only by experienced mechanics. Sockets and spigots shall be washed with soapy water before slipping the gland and gasket over the spigot end of the pipe. The spigot shall be inserted into the socket full depth, then backed off ¼-inch to provide clearance for expansion. The gasket shall be brushed with soapy water and shall be pushed into position making sure that it is evenly seated in the socket. The gland shall then be moved into position for compressing the gasket. All bolts and nuts shall be made "finger-tight." For joints made in trenches, the bolts shall be tightened to a uniform permanent tightness, using a torque wrench for tightening. Bolts shall be tightened alternately 180 degrees apart. Measurement for payment of sewer lines will be made along the top of the pipe from center to center of manholes. Cast Iron or Ductile Iron fittings will be paid for on the basis of the published weight of the fitting itself, exclusive of the follower rings and gaskets.

(2) Push-On Joints: The groove and bell socket shall be thoroughly cleaned and lubricated before the gasket is inserted. Before inserting the gasket it shall be thoroughly lubricated and manufacturers' instructions shall be followed for proper facing and seating of gasket. After the gasket is in place and just prior to joint assembly a generous coating of lubricant shall be applied to the exposed gasket surface. The lubricant used shall be a lubricant supplied by the pipe manufacturer. The plain end shall be inspected and any sharp edges which might damage the gasket shall be removed by means of a file or power grinder. Pipe that is cut in the field

must be ground and beveled before assembly. Prior to inserting the plain end of the pipe into bell socket lubricant shall be applied to the beveled nose of the pipe. Small pipe may be pushed home with a long bar but large pipe may require additional power such as jack, lever or backhoe. A timber header shall be used between the bell and bar or other power to avoid damage to the pipe. During assembly of the pipe the joint must be kept straight while pushing. Pipe may be deflected if desired but only after the assembly is completed. Measurement for payment of sewer lines will be made along the top of the pipe from center to center of manholes. Cast Iron or Ductile Iron fittings will be paid for on the basis of the published weight of the fitting itself, exclusive of the follower rings and gaskets.

(3) Mechanical Joint or Push-on Joint Pipe on Piers: Mechanical or Push-on Joint Pipe may be used on piers in gravity sewer lines. Pipe shall be laid with a ¼-inch clearance in each joint to provide for expansion. Jointing of pipe shall be as described above. On mechanical joint pipe the bolts shall be tightened alternately 180 degrees apart but be left "finger-tight" until the sewage is diverted into the sewers; then bolts shall be further tightened to a sufficient amount which will prevent leakage of the joint, but which will not prevent slippage which may occur because of temperature stresses. Measurement for payment of Ductile Iron Pipe constructed on piers will be from end to end of Ductile Iron Pipe.

M. **Joining of PVC Pipe with Elastomeric Joints:** Proper implements, tools and equipment shall be used for placement of the pipe in the trench to prevent damage. Under no circumstances may the pipe be dropped into the trench. In subfreezing temperatures, caution shall be exercised in handling pipe to prevent impact damage. All pipe shall be carefully examined for cracks, nicks, gouges, severe scratches, voids, inclusions and other defects before laying. If any pipe is discovered to be defective after having been laid, it shall be removed and replaced with sound material.

(1) Assembly of Gasketed Joint: The assembly of the gasketed joint shall be performed as recommended by the pipe manufacturer. The elastomeric gaskets may be supplied separately in cartons or pre-positioned in the bell joint or coupling at the factory. When gaskets are color coded, the Contractor shall consult the pipe manufacturer or his literature for the significance. In all cases, the gasket, the bell or coupling interior, especially the groove area (except when gasket is permanently installed) and the spigot area shall be cleaned with a rag, brush or rag to remove any dirt or foreign material before the assembling. The gasket pipe spigot bevel, gasket groove, and sealing surfaces shall be inspected for damage or deformation. When gaskets are separate, only gaskets which are designed for and supplied with the pipe shall be used. They shall be inserted as recommended by the manufacturer.

Lubricant used shall be supplied by the pipe manufacturer and shall be applied as specified by the pipe manufacturer. No joints shall be assembled without the use of proper lubrication and in strict accordance with the manufacturers requirements.

(2) Lubrication: After lubrication, the pipe is ready to be joined. Good alignment of the pipe is essential for ease of assembly. Align the spigot to the bell and insert the spigot into the bell until it contacts the gasket uniformly. Do not swing or "stab" the joint; that is, do not suspend the pipe and swing it into the bell. The spigot end of the pipe is marked by the manufacturer to indicate the proper depth of insertion.

If undue resistance to insertion of the pipe end is encountered, or the reference mark does not position properly, the joint shall be disassembled and the position of the gasket checked. If it is twisted or pushed out of its seat ("fishmouthed"), the Contractor shall inspect components, repair or replace damaged items, clean the components, and repeat the assembly steps. Both pipe lengths must be concentric alignment. If the gasket was not out of position, the Contractor shall verify proper

location of the reference mark. The reference mark shall be relocated if it is out of position. .

(3) Field Cut: Field cut pipe to be joined shall be square cut using a hacksaw, handsaw or power saw with a steel blade or abrasive disc. The pipe shall be marked around its entire circumference prior to cutting to assure a square cut. A factory-finished beveled end shall be used as a guide for proper bevel angle, and depth of bevel plus the distance to the insertion reference mark. The end may be beveled using a pipe beveling tool or a wood rasp which will cut the correct taper. A portable sander or abrasive disc may be used to bevel the pipe end. Any sharp edges on the leading edge of the bevel must be rounded off with a pocket knife or a file.

N. **Alignment and Grade:** All gravity sewer mains shall be installed using a pipe laser to insure that proper grade and alignment are maintained throughout the installation. Contractor shall be responsible for providing and using a pipe laser, transit, and level in good working order and making this equipment available to the owner for use in verification of line and grade of all sewer mains. If a main is found to be out of line or grade after installation the contractor is responsible for making all repairs at no additional cost to the owner.

O. **Precast Concrete Manholes**: Precast concrete manholes shall be bedded on not less than six inches (6") of compacted crushed stone at Contractor's expense. The crushed stone shall extend not less than six inches (6") outside the walls of the manhole, and shall be compacted under entire length of pipe within manhole excavation. Manholes shall be 4, 5, and 6 feet in diameter as determined from the schedule of pipe sizes and line deflections, or as shown. The top of manholes outside of roads, streets, and highways shall extend a minimum of 12 inches above final grade unless otherwise noted.

(1) Connection of Pipe to Manhole: Connections of pipe to manhole for 4-inch through 15-inch pipe shall be made with a flexible joint system. The joint system shall be a neoprene or synthetic rubber boot or sleeve, either cast or core drilled into the wall of manhole. The boot or sleeve shall be clamped and seated to the pipe with a stainless steel band. The boot or sleeve system shall be "LOCK JOINT FLEXIBLE MANHOLE SLEEVE" as manufactured by Interpace Corporation, Parsippany, New Jersey or "KOR-N-SEAL" as manufactured by National Pollution Control Systems, Inc., Nashua, New Hampshire or equal. Connections of pipe to manhole for 18-inch pipe and above shall be made with a collar of mortar and brick. The opening between the pipe and the manhole shall have a minimum clearance of one inch (1") and shall be filled from the inside of the manhole with a non-shrink grout.

(2) Adjustment: The top of the concentric top section shall have a minimum wall thickness of eight inches (8") to accommodate precast concrete adjustment rings. Precast adjustment rings must be installed using at least 2 rings of bitumastic sealant and bedded in non-shrink grout around the perimeter of the ring. A maximum of three (3) brick courses will be allowed for adjustment of manhole to required grade. The top of manholes outside of roads, streets, and highways shall be built to grade twelve inches (12") above ground surface unless otherwise shown on the Drawings. Manholes in roads, etc. shall be built to grade designated by the Owner. Vented manholes shall be constructed to elevations as shown on the Drawings.

(3) Drop Connections: Drop connections will be required when the drop exceeds 2 feet or where called for on the drawings. Drop pipe shall not be smaller than 8-inches. Generally, drop pipe shall be one size smaller than the sewer which they serve. Openings in walls of precast concrete manholes for drop connections shall not be made at joints. Drop connection fittings and riser pipe shall be encased in brick and mortar or formed Class "C" concrete. Drop connections for both brick and precast

concrete manholes shall conform with typical details as shown on the Drawings. Drop connections shall be carefully backfilled to prevent dangerous side pressures.

(4) Manhole Inverts: Manhole inverts shall be carefully constructed with cement grout, Class "B" concrete, or cement mortar brickwork; special care shall be taken to lay the channel and adjacent pipes to grade. Cement mortar shall be made of one (1) part cement and two (2) parts clean sharp sand. Channels shall be properly formed, rounded, and troweled smooth. The connections of the sewer with the wall and the channel of the manhole shall be tight and smooth.

(5) Manhole Steps: Manhole steps shall conform to the details shown. Steps for brick manholes shall be installed along a vertical centerline, on approximately 15" centers. Steps shall be firmly and securely built into manhole walls as brickwork proceeds. Steps for precast concrete manholes shall be installed along a vertical centerline, on approximately 14"to 16" centers.

(6) Future Sewer Connections: Where shown, a twelve inch (12") long pipe stub for future sewers, of such size as may be designated, shall be laid to proper grade and alignment and plugged with a factory plug with same type joint as used on the sewer pipe.

(7) Manhole Frame and Covers: Manhole frames and covers shall be "Heavy Duty" and constructed in accordance with ASTM A 48 Class 30. The frame weight shall be 190 pounds and the cover weight shall be 130 pounds. The frame pattern shall be V-1480-10 and the cover pattern shall be V-1480-1 as manufactured by Vulcan Foundry Corp, or equal. The covers for the manholes shall be cast with the word "SEWER" on the face. All manhole frames must be cast into the manhole riser or attached to the precast manhole using 4-¾" diameter wedge type anchor bolts. Each frame must be sealed with a minimum of one complete ring of bitumastic sealant between the frame and precast manhole. The outside edge of each frame must be grouted with non-shrink grout; the grout must be tapered from the edge of the manhole to the top of the frame.

(8) Payment: Payment for precast concrete manholes will be made from actual field measurements to the nearest one-tenth foot as stated in the Proposal. Measurement for payment will be made from manhole invert to top of precast concrete cone. Payment for drop connections will be made at the unit prices stated in the Proposal, and shall include all necessary pipe, pipe fittings, brick or concrete encasement of drop pipe and extension of manhole base slab. Measurement for payment shall be from invert of TEE to invert of ELL. Payment for manhole frames and covers will be made in accordance with the unit prices stated in the Proposal for the various types. No extra payment will be made for 6-inches of compacted crushed stone bedding under manhole, for manhole steps, for constructing manhole inverts or for furnishing and laying future sewer connections, the cost thereof to be included in the unit prices bid for manhole construction.

P. **Connections to Existing Manholes**: At locations where new sewers are shown to be connected to existing manholes, the Contractor may temporarily block and/or divert sewage flows to facilitate construction operations. The work shall consist of making the opening in the manhole wall, inserting the new pipe to the elevation shown, filling the space in the wall around the pipe with non-shrink mortar, and constructing and remodeling manhole inverts. High-early strength cement shall be used for mortar in order that proper channels may be formed in manhole bottoms with a minimum interruption of service to the existing sewer. The price bid for this work shall include all costs of labor, material, and equipment required to complete each connection and shall include the costs involved in blocking and/or diverting sewage flows, and shall include all costs of delays, temporary works, and maintaining existing

sewers in service. No payment will be made for a connection to an existing pipe or manhole stub.

Q. Connections to Existing Sewers: At locations where new sewers are shown to be connected to existing sewers at a new manhole, the Contractor shall first expose the existing sewer and install a supporting timber beam with suitable straps around the pipe so as to bridge the excavation for the new manhole. The manhole shall then be constructed complete with invert and frame and cover. Under special conditions the Contractor may temporarily block and/or divert sewage flows to facilitate construction operations. Actual physical connection of the sewers will be made at a later date, as directed. The price bid for this work shall include all costs of labor, material, and equipment required to expose and support the existing sewer, block and/or divert sewage flows, make future physical connections, as well as all costs of delays, temporary works, and maintenance of existing sewers in service. Manholes, manhole frames and covers, and drop connections, if required, will be paid for separately in accordance with the unit prices bid for the various items.

R. House Service Branches: House service branch connections may be made with wyes, tees or pipe saddles made of the same material as the carrier pipe. In general, house service branches shall incline upward and should match as closely as possible the alignment of the existing services. The Contractor shall use whatever fittings are necessary and up to 10 linear feet of service pipe to properly align the service connection. Service pipe shall be ductile iron or HDPE pipe of the same size as the existing service, except the minimum size shall be 4". For new sewers, the service shall be 6" ductile iron pipe. The 6" ductile iron pipe will be run to the edge of the road right of way. Then a fernco will be used to connect a short 3 foot stub of 4" PVC with a plug. A 4x4 treated wood post shall be set in the ground at the edge of the service, painted green and extend at least 3 foot above grade. Where required, short radius bends shall be used to connect the service branch to the house service line. Pipe service branches, together with bends, shall be placed on a compacted bed of crushed stone in such a manner as to be self-supporting and to relieve the strain on branches and bends. Payment for wyes, tees or saddles shall be at the price stated in the Proposal in addition to the prices bid for the completed sewer line. Payment for reconnecting existing services shall be made at the unit price as stated in the Proposal and shall include all work necessary to complete the connection, including, but not limited to, all fittings, pumping, bailing, crushed stone, and up to 10 linear feet of service pipe.

S. **Channel Excavation**: At locations where storm water drainage is obstructed by sewer construction, the Contractor shall excavate new channels or widen and lower the grade of existing channels in accordance with Drawings and directions given. No separate payment will be made for the work of this section. The cost of such work, and all costs incidental thereto, shall be included in the unit price bid for sewers.

T. **Concrete Encasement of Pipes**: Where directed by the Owner, sewer pipe shall be completely encased with Class "B" concrete. The trench shall first be excavated not less than six inches (6") below the bell of the pipe and the pipe laid to line and grade on concrete blocking or equal. Concrete shall then be placed to the full width of the trench, but in no case less than six inches (6") from the pipe bell on either side of the trench, and to a height of not less than six inches (6") above the top of the pipe bell. No backfill material shall be placed in the trench for a period of at least twenty four (24) hours after the concrete encasement has been placed. Concrete encasement will be paid for at the unit price stated in the Proposal and shall include the costs of the additional depth of excavation, the furnishing of concrete blocking, and the laying of pipe to line and grade on the blocking.

U. **Polyethylene Encasement**: Polyethylene encasement shall be installed where required by the Owner due to corrosive soil conditions or potential stray currents in the soil (e.g. gas line easements) in accordance with ANSI/AWWA A21.5/C105.

V. **Closing Pipe:** When the work of pipe-laying is suspended for the night, and at other times, the end of the sewer shall be closed with a tight cover. The Contractor shall be responsible for keeping the sewer free from obstruction.

W. **Inspection and Testing of Manholes**: Vacuum Testing of precast concrete manholes shall be performed on all manholes on a given project. All testing shall be performed in accordance with the requirements of ASTM C 1244-93. All lift holes and any pipes entering the manhole shall be plugged prior to initiating the vacuum test. A vacuum will be drawn and the vacuum drop over a specified time period will be used to determine the acceptability of the manhole.

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 from 10 in. of mercury 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.

Table 1 – Minimum Test Times for Various Manhole Diameters

Depth (ft)	Diameter, in.								
	30	33	36	42	48	54	60	66	72
	Time, s								
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	46	51	57
16	22	24	29	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	57	65	72	81
22	31	33	39	46	55	61	72	79	89
24	33	36	42	51	58	64	78	87	97
26	36	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	96	108	121

X. **Cleaning Up:** Before the work is considered complete, all material not used, and rubbish of every character must be removed from the project. All streets, sidewalks, curbs, fences and other private or public facilities and structures disturbed must be in essentially good condition as existed before the work was done. The Contractor shall replace any subsequent settlement of backfill or pavement over trenches and the surfaces brought to grade.

Y. **Inspection and Testing**: Sewer lines and appurtenances will be inspected by one of the following methods hydrostatic infiltration and exfiltration testing as per ASTM C 1091 – 90 or low pressure air test as per ASTM C 829 – 90. The maximum acceptable leakage rate shall not exceed 25 gallons per day per inch diameter per mile of sewer. In addition, the sewer mains shall be inspected using closed circuit television methods approved by the Owner. All visible leaks shall be repaired regardless of whether infiltration, exfiltration or air test is within allowable limits. No sewer will be accepted until leakage tests demonstrate

compliance with one of the leakage test methods. All sanitary sewer lines shall be tested for leakage, in the presence of the Owner or his representative. Tests shall be conducted by one or a combination of the following two methods. Where natural ground water levels stand a minimum of two feet (2') above the top of the pipe, the amount of leakage may be determined from measurements made at the lower end of the sewer section under test. Where natural ground water levels do not stand two feet (2') above the top of the pipe, an exfiltration test shall be conducted on each section of sewer. Tests shall be as follows:

(1). Infiltration Test: The infiltration test shall be performed up to an average maximum hydrostatic head of ten feet (10'). Sewers above the test section shall be closed before testing by the installation of suitable watertight bulkheads. The length of the test section shall be determined by the Engineer. The average of six readings at five-minute intervals will be used to determine the rate of infiltration for any one-test section. The rate of infiltration of ground water into any test section of sewer, including manholes, shall not exceed 25 gallons per day per inch diameter per mile.

(2). Exfiltration Test: For the exfiltration test the ends of the pipe in the test section shall be closed with suitable watertight bulkheads. Inserted into each bulkhead at the top of the sewer pipe shall be a 2-inch pipe nipple with an elbow. At the upper end of the test section a riser pipe shall be installed. The test section of pipe shall be filled through the pipe connection in the lower bulkhead, which shall be fitted with a tight valve, until all air is exhausted and until water overflows the riser pipe at the upper end. Water may be introduced into the pipe twenty-four (24) hours prior to the test period to allow complete saturation. House service lines, if installed, shall also be fitted with suitable bulkheads having provisions for the release of air while the test section is being filled with water. During the test period, which shall extend over a period of thirty (30) minutes, water shall be introduced into the riser pipe from measured containers at such intervals as are necessary to maintain the water level at the top of the riser pipe. The total volume of water added during the thirty- (30) minute test period that should not exceed that shown for infiltration in (1) above.

(3). Air Test: After the pipe has been installed and backfilled, the sewer may be tested between manholes by low pressure air test. The air test may be required by the Engineer instead of or in addition to the infiltration or exfiltration test. The pipe shall be filled with air slowly to a constant pressure of 4.0 psig. The pressure shall then be maintained between 3.5 and 4.0 psig for not less than two minutes. The sewer is acceptable if the loss of air from 3.5 psig to 2.5 psig is not less than the time shown in the following table.

Time per 100 Feet of Pipe		
Pipe Diameter(Inches)	Min.	Sec.
8	1	12
10	1	30
12	1	48
14	2	00
15	2	06
16	2	12
18	2	24

20	2	48
21	3	00
24	3	36
27	4	12
30	4	48
36	6	00
42	7	18
48	8	30
54	9	42

X. **Acceptance of Work**: Sewer lines and appurtenances will not be considered for acceptance until all provisions of the Specifications have been complied with, until all tests have been satisfactorily completed, and until inspection of the work has been made. Sewage flows shall not be diverted into new sewers until after such time as final inspection of the lines has been made by the Owner, and permission granted therefore.

Y. **Cleaning and Internal Inspection**: Before acceptance of any sewer or systems of sewers, lines shall be cleaned and inspected in accordance with these Specifications. Where any obstruction is met, the Contractor will be required to clean the sewers by means of jetting, rods, swabs, or other instruments. Lines and manholes shall be clean before final inspection. Final inspection shall be performed by the Contractor with the aid of closed circuit television equipment in the presence of the Owner or his representative. The television picture shall be videotaped or recorded on a DVD as an inspection record and written logs prepared which indicate the location of service lines, leaks and other obvious construction defects such as broken sewer pipes, separated joints, etc.

Pipe lines shall be straight and show a uniform grade between manholes. The Contractor shall be required to correct any variations there from or other deficiencies which may be disclosed during the inspection. No extra payment will be made for cleaning, the cost thereof to be included in the prices bid for sewers. Internal inspection by closed circuit television will not be paid for on a linear foot basis and shall be included in the unit price for the sewers in the proposal. If problems are encountered during the video inspection and cleaning or repairs are required, the sewer mains in question must be re-inspected after they are cleaned or repaired at no cost to the Owner.

Z. **Erosion Control**: All sewers will be installed in accordance with the requirements under Section 312500 Erosion and Sedimentation Control. No separate payment will be made for this work except as provided for in the bid.

END OF SECTION