SECTION 33 05 26

TRACER WIRE

PART 1 - GENERAL

1.01 Section Includes

A. Furnishing and installation of tracer wire and accessories for non-metallic sewer laterals, force main, and water main.

1.02 Related Sections

A. Section 33 05 23.12 - Directional Boring.

B. Section 33 11 13 - Water Main Construction.

C. Section 33 31 00 - Sanitary Sewer Construction.

D. Section 33 33 13 - Pressure Sewer.

E. Section 33 34 00 - Force Main.

F. Section 33 41 13 - Storm Sewer Construction.

PART 2 - PRODUCTS

2.01 Wire

A. No. 12 AWG PVC coated copper conductor rated for wet conditions.

B. Color:
   1. Water Main - Blue.
   2. Sanitary Sewer Main/Laterals - Green.
   3. Sewer Force Main - Green.
   4. Storm Sewer - Brown.

2.02 Terminal Box

A. Type A: Cast iron rim and lid, ABS plastic body with 2 ½-inch shaft and flared base, terminal blocks on lid, 24” length, lid marked water; Bingham & Taylor P200NFG or equal.

B. Type B: Cast iron valve box top, approximate length of 24 inches, lid marked sewer or water.

C. Unless otherwise noted within the Contract Documents, use Type A for terminal boxes located within turf areas, sidewalks, or driveways and Type B for terminal boxes located within street paving.

2.03 Accessories

A. Connectors: Water tight connectors designed for electrical continuity.

PART 3 - EXECUTION

3.01 Installation - General

A. Tracer wire shall be installed in the same trench, inside bore holes, and inside casing with pipe during the pipe installation.

B. Tracer wire shall be laid flat on the top of the pipe and taped to the pipe at minimum 10-ft. intervals.

C. The wire shall be protected from damage during installation of the pipe. No breaks or cuts in the tracer wire or wire insulation shall be permitted.

D. Tracer wire shall be continuous as much as possible. Where splices are necessary use connectors. Soldering or twisted wires are not allowed.

E. At the point of connection to cast or ductile iron pipe, the tracer wire shall be connected to the pipe by cad welding. The connection shall be completely sealed with a mastic manufactured for underground use.

F. For laterals, the single tracer wire shall be connected to the main line tracer wire with a connector.

G. Bring the wire to the surface at maximum intervals of 500 feet or as shown on the Drawings. Wires shall terminate within a terminal box. Provide an extra 18 inches of wire at the termination point.

H. For directional drilling, auguring, or boring installations two tracer wires shall be installed.

3.02 Testing

A. Contractor shall perform a continuity test on all tracer wire in the presence of the Engineer. If the tracer wire is found to be not continuous, Contractor shall repair the failed segment at his own expense.

3.03 Measurement and Payment

A. Unless otherwise indicated within the Contract Documents, furnishing and installation of tracer wire is incidental to the Work.

B. Terminal boxes will be paid for at the Bid Price. If a Bid Item for terminal boxes is not included on the Bid Form, the furnishing and installation is incidental to the Work.

END OF SECTION

SECTION 33 11 13

WATER MAIN CONSTRUCTION

PART 1 - GENERAL

1.01 Section Includes

A. Furnishing and installation of water main, valves, and hydrants.

B. Furnishing and installation of service laterals.

1.02 Related Sections

A. Section 33 05 26 - Tracer Wire.

B. Section 31 23 33 - Utility Excavation, Backfilling and Compaction.

1.03 References

A. ASTM B88 - Seamless Copper Water Tube.

B. ASTM D2487 - Classification of Soils for Engineering Purposes.

C. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

D. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-inch through 48-inch (75 mm through 1200 mm) for Water and Other Liquids.

E. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.

F. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.

G. AWWA C153 - Ductile-Iron Compact Fillings, 3 In. Through 24 In. (76 mm through 610 mm) and 54 In. Through 64 In. (1400 mm through 1600 mm) for Water Service.

H. AWWA C502 - Dry-Barrel Fire Hydrants.

I. AWWA C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.

J. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

K. AWWA C605 - Underground Installation of Polyvinyl Chloride (PVC) Pressure pipe and Fittings for Water.

L. AWWA C651 - Disinfecting Water Mains.

M. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe 4-inch through 12-inch, for Water Distribution.

1.04 Submittals

A. Product data on pipe, fittings, valves, and hydrants.

B. As built measurements.

1.05 Quality Assurance

A. Provide at least one person thoroughly trained and experienced in the skills required, who is completely familiar with the work described in this section, and who shall be present at all times during progress of the work of this section and who shall direct all work performed under this section.

B. All materials shall be new and free from defects. Each length of pipe shall be clearly marked with

the manufacturer's name, type of pipe, and the class of pipe.

C. Hydrostatic pressure testing and electrical conductivity testing required.

D. Disinfection and bacteriological sampling required.

PART 2 - PRODUCTS

2.01 Pipe Materials

A. Ductile Iron Pipe:
   1. Pipe: AWWA C151, Class 52; cement-mortar lining, AWWA C104.
   2. Joints: Mechanical joint or push-on, AWWA C111.
   3. Electrical Conductivity: Factory applied terminals with copper straps or cables capable of carrying 600 amps.

B. PVC Pipe (Use only when indicated on Drawings)
   1. Pipe: AWWA C900, Class 150 (DR-18) with cast iron O.D.
   2. Joints: Rubber gasket.

2.02 Fittings

A. Ductile Iron, AWWA C110 or AWWA C153.

B. Mechanical Joint Restraint:
   1. Ductile iron mechanical joint restraining gland.
   2. Ductile Iron Pipe: MEGALUG 1100 or equal.
   3. PVC Pipe: MEGALUG 2000PV or equal.

2.03 Gate Valves

A. Acceptable Manufacturers: Kennedy, Model KS-RW; American Flow Control, Series 2500; or equal.

B. Gate Valves:
   1. Resilient seated, ductile iron.
   2. AWWA C515, 250 psi working pressure.

C. Valve Construction
   1. Meet appropriate AWWA specification.
   2. All internal ferrous surfaces shall be epoxy coated. The exterior of buried valves shall be coated with epoxy.
   3. Valves to be field painted shall have all cast iron surfaces coated with primer.
   4. Joints: Flange joints, ANSI 16.1, Class 125; mechanical joints, AWWA C111.
   5. Valves shall be non-rising stem with square stem operating nut for socket wrench operation.
   6. All valves shall be opened by turning left.

D. Valve Box
   1. Valve Box: Cast iron 3-piece box with screw type adjustment. The word "WATER" shall be cast into box cover.
   2. Valve Box Centering Device:
      a. A valve box centering device that sets on the valve and is constructed of polyurethane coated steel with a rubber gasket between the device and the valve; Adapter, Inc. or equal.
      b. A factory attached valve box centering device consisting of stainless steel clips, American Flow Control Tenor Valve Box Centering Deice or equal.

E. Alternate Valve Box (Use if indicated in Contract Documents)
   1. Complete assembly composed of the valve box and extension stem. The valve box top shall be cast iron and the upper and lower pipes may be cast iron or high density polyethylene. The box assembly shall be adjustable.
   2. The stem assembly shall be of a telescoping design that allows for variable adjustment length. The design shall include a means to prevent the stem assembly from disengaging when fully extended. The extension stem shall survive a torque test of 1,000 ft-lb without

failure.
3. Manufacturer: American Flow Control Trench Adapter or equal.

2.04 Fire Hydrants

A. Hydrant: Dry-barrel type, AWWA C502; Waterous Pacer Model WB-67 with a 16" upper barrel section, unless a specific manufacturer is indicated elsewhere in the Contract Documents.

B. Design
1. Traffic model type equipped with a barrel ground-line flanged coupling and main rod coupling designed to fail completely and uniformly when the hydrant is impacted by a motor vehicle. Weakened steel or weakened cast iron bolts used in breakable barrel couplings are not acceptable.
2. Designed for working pressure of 150 psi.
3. Main valve shall open against system pressure and shall be not less than 5 1/4-inch.
4. No excavation shall be required to remove main valve and movable parts of main valve.
5. Drain port.
6. Bury length of 7.5 feet from bottom of connecting pipe to ground line.
7. Mechanical joint inlet connection.
8. Open by turning counterclockwise.
9. Outlets: Two 2-1/2-inch hose nozzles, one 4-1/2-inch pumper nozzle with National Standard threads and caps with chains.
10. Pentagonal operating nuts.

C. Paint: Red, unless indicated otherwise. Paint in accordance with AWWA C502, Section 4.2.

2.05 Tapping Sleeve

A. Tapping Sleeve: Carbon steel, epoxy coated, mechanical joint.

B. Manufacturer: Smith-Blair 622, Dresser 610, or equal.

2.06 Service Lateral

A. Pipe: Copper, ASTM B88, Type K.

B. Polyethylene: ASTM D2737, SDR 9, copper tube size. Provide stainless steel inserts, Ford Meter Box Company or equal.

2.07 Corporation Stops

A. Brass corporation stop with taper thread inlet and conductive compression outlet.
1. ¾" and 1": Mueller Ground Key Corporation Valve, H-15008 or equal.
2. 1 ½" and 2": Mueller Ori-Corp H-15013 or equal.

2.08 Curb Stops

A. Brass curb stop with conductive compression inlet and outlet, quarter turn check, and Minneapolis top.
1. ¾" and 1": Mueller Mark II Oriseal H-15155 or equal.
2. 1 ½" and 2": Mueller 300 Ball Curb Valve B-25155 or equal.

2.09 Curb Box

A. Cast iron extension type, Minneapolis pattern with stationary rod, 1 ¼" upper section, 7-foot length, pentagon nut.

B. Mueller H-10300 or equal.

2.09 Service Saddles

A. Ductile Iron Pipe: Double strap, epoxy-coated ductile iron with stainless steel straps; Smith-Blair 317 or equal.

B. PVC Pipe: Stainless steel, single or double bolt; Smith-Blair 371, 372 or equal.

2.10 Bedding and Cover Material

A. Provide bedding and cover material meeting the requirements of ASTM D2321, Class IA, IB, II or III described as follows:

1. Class IA - Clean angular crushed stone, crushed rock, or crushed gravel conforming to the following gradation:

Sieve Size	% Passing By Weight
1”	100
3/4”	90 - 100
3/8”	20 -55
No. 4	0 - 10
No. 8	0 - 5

2. Class IB - Clean angular crushed stone, crushed rock, or crushed gravel conforming to the following gradation:

Sieve Size	% Passing By Weight
1/2”	100
3/8”	85 - 100
No. 4	10 - 30
No. 200	0 - 5

3. Class II - Clean coarse-grained soils free from organic matter, trash, debris, stones larger than 1-inch, and frozen material and classified in ASTM D2487 as follows:

GW - Well-graded gravels, gravel-sand mixtures, little or no fines.
GP - Poorly-graded gravels, gravel-sand mixtures, little or no fines.
SW - Well-graded sands, gravelly sands, little or no fines.
SP - Poorly-graded sands, gravelly sands, little or no fines.

Excavated trench material may be used if it meets the above material requirements.

4. Class III - Coarse-grained soils with fines free from organic matter, trash, debris, stones larger than 1-inch, and frozen material and classified in ASTM D2487 as follows:

GM - Silty gravels, gravel-sand-silt mixtures.
GC - Clayey gravels, gravel-sand-clay mixtures.
SM - Silty sands, sand-silt mixture.
SC - Clayey sands, sand-clay mixtures.

Excavated trench material may be used if it meets the above material requirements.

PART 3 - EXECUTION

3.01 Handling of Materials

A. Handle all material with care to avoid damage. No material shall be dropped.

B. Remove all defective material from the job site.

C. Store materials in a manner that protects them from damage. Store hydrants and valves in a manner that provides protection from damage by freezing.

3.02 Lines and Grade

A. Lay pipe to the lines and grades shown on the Drawings or given by the Owner’s Representative.

B. Locate all fittings, valves, and hydrants as shown on the Drawings or as given by the Owner’s

Representative.

3.03 Laying Pipe

A. Unless otherwise indicated on the plans, all water mains, including hydrant leads, shall have a minimum depth of cover of 7.0 feet.

B. Handle pipe, fittings, valves and hydrants in a manner to prevent damage. Use suitable equipment when lowering materials into the trench.

C. Before pipe is laid, remove all foreign matter from the inside and remove all excess coating material, blisters, oil, grease, dirt and moisture from the inside of the bell end and the outside of the spigot end.

D. The interior of the pipe shall be kept clean during laying, and no trench water shall be allowed to enter the pipe.

E. Assemble joints in accordance with AWWA C600 for ductile iron pipe and AWWA C605 for PVC pipe.

F. Pipe lines intended to be straight shall be so laid. Deflections from straight line or grade, when required, shall not exceed those listed below:

Maximum Deflection Full Pipe, Push-On Joints - D.I. Pipe

Pipe Diameter	Deflection Angle	Maximum Deflection - Inches 18-Ft. Length	20- Ft. Length
4”	5°	19	21
6”	5°	19	21
8”	5°	19	21
10”	5°	19	21
12”	5°	19	21

Maximum Deflection Full Pipe, Mechanical Joints D.I. & PVC

Pipe Diameter	Deflection Angle	Maximum Deflection - Inches 18-Ft. Length	20- Ft. Length
4”	8°-18’	31	35
6”	7°-7’	27	30
8”	5°-21’	20	22
10”	5°-21’	20	22
12”	5°-21’	20	22

PVC pipe with push-on joints shall not be deflected at joints. Pipe may be curved in accordance with the following table:

Longitudinal Bending Push-On Joints - PVC Pipe	
Pipe Size Inches	Minimum Bending Radius Feet
4	100
6	145
8	190
10	275235
12	275

3.04 PVC Pipe Tracer Wire

A. Furnish and install tracer wire for PVC water main in accordance with Section 33 05 26.

3.05 Pipe Bedding and Cover

A. Place 4" of bedding material beneath pipe.

B. Place bedding material around the pipe to the spring line. Work the material in and around the pipe by hand to provide uniform support.

C. Place cover material carefully to a level six inches above the pipe.

3.06 Separation from Sewer

A. Lay water mains a minimum of 8 feet from sewer lines (center to center).

B. When water mains cross over sewers, provide a minimum of 12 inches from the bottom of the water main to the top of the sewer.

C. When water mains cross under sewers, provide a minimum of 18 inches from the top of the water main to the bottom of the sewer.

3.07 Valve Installation

A. Provide valve box for each valve unless the plans call for a valve manhole.

B. Install valve adapter on valve and set box on adapter, as per manufacturer's instructions.

C. Set valve box vertical with the cover flush with finish grade. Install box so that there is a minimum of six inches of adjustment above and below finish grade elevation.

3.08 Hydrant Installation

A. Set all hydrants plumb and have the nozzles parallel with or at right angles to the curb line or street with the pumper nozzle facing the curb or street.

B. Set hydrant height above grade as shown on the Standard Detail Drawings.

C. Connect hydrants to the main with a 6-inch lead. Install a gate valve on the lead unless specifically deleted.

D. Provide drainage at the base of the hydrant by placing crushed stone wrapped in geotextile at the base of the hydrant. The stone shall extend at least 6 inches above the hydrant drain port. Where ground waters rise above the drain port or when the hydrant is located within 8 feet of a sanitary or storm sewer, plug the drain port.

E. Provide plastic bag or poly-wrap covering over top of hydrant until the water main has been accepted by Engineer for fire protection.

3.09 Hydrostatic Testing

A. All water main and water services shall be tested hydrostatically to a pressure of 150 psi in accordance with AWWA C600. Perform testing in the presence of the Engineer or authorized representative of the Owner.

B. Water services that serve fire protection systems only shall be tested as in A above except that the test pressure shall be 200 psi.

C. The Contractor shall provide all equipment and shall perform all work required in connection with the tests.

D. Each section tested shall be slowly filled with water, care being taken to expel all air from the pipes.

E. Conduct leakage test at the same time or following the pressure test in accordance with AWWA C600 for ductile iron pipe and AWWA C605 for PVC pipe. The leakage test shall be for a minimum of two hours. The test pressure shall be maintained within 5 psi of the specified test pressure. The allowable leakage shall be determined by the following equation:

1. AWWA C600 - Ductile Iron Pipe

$$L = \frac{SD(P)^{1/2}}{133{,}200}$$

L = allowable leakage in gallons per hour.
S = length of pipe tested in feet.
D = nominal pipe diameters in inches.
P = average test pressure in psi.

Allowable Leakage - GPH/1,000 Ft. 150 PSI Average Test Pressure		Allowable Leakage - GPH/1,000 Ft. 200 PSI Average Test Pressure	
Pipe Size Inches	Allowable Leakage Gallons per Hour	Pipe Size Inches	Allowable Leakage Gallons per Hour
3	0.24	3	0.28
4	0.33	4	0.38
6	0.50	6	0.57
8	0.66	8	0.76
10	0.83	10	0.96
12	0.99	12	1.15

2. AWWA C605 - PVC Pipe

$$L = \frac{ND(P)^{1/2}}{7,400}$$

L = allowable leakage in gallons per hour.
N = number of joints in the length of pipe tested.
D = nominal pipe diameters in inches.
P = average test pressure in psi.

Allowable Leakage for 50 Joints (GPH)		
Pipe Size Inches	Average Test Pressure (PSI)	
	150	200
3	0.25	0.29
4	0.33	0.38
6	0.50	0.57
8	0.66	0.76
10	0.83	0.96
12	0.99	1.15

F. Any section of pipe that fails the test shall be repaired and retested. The cost of the testing shall be included in the cost of the water main. No separate payment will be made.

3.10 Tapping Sleeve Testing

A. All tapping sleeves shall be hydrostatically tested at a minimum of 150 PSI prior to tapping.

3.11 Electrical Conductivity

A. Provide electrical conductivity (not applicable to PVC pipe). Bolt copper straps of push-on pipe together. For mechanical joint pipe, bolt copper strip to bell. Bare metal on bell prior to connection.

B. For pipes cut in the field, exothermically weld the bonding straps to the pipe. The pipe metal shall be bared at the point of attachment. Coat bear metal with asphaltic material.

C. Provide conductivity across all gate valves and across the hydrant bottom using a copper strap or #4 AWG bare copper wire welded to pipe on either side of the valve or hydrant bottom.

3.12 Thrust Restraint

A. Thrust restraint is required for all bends, caps, plugs, tees, and valves adjacent to tees. Thrust restraint shall be provided by use of concrete buttresses and wedge action restraining glands.

B. Concrete buttresses shall be poured against firm, undisturbed ground. When concrete buttresses cannot be placed against undisturbed ground they shall be placed against fill material of composition conforming to the requirements of ASTM C12 or ASTM D2321 as applicable for rigid and flexible pipe respectively, compacted to 95 percent of the modified proctor density for the material. The buttresses shall be constructed to the minimum dimensions as shown on the contract

drawings or as required by the Engineer. All buttresses shall be formed to keep the joints free of concrete.

C. Solid precast concrete blocks may be used in lieu of the poured buttresses when approved by the Engineer. When concrete blocks are used, they shall be stepped-out to match the minimum dimensions required for poured concrete buttresses.

D. Ductile iron or PVC pipe connecting to HDPE pipe must be restrained a sufficient distance upstream to prevent joint separation due to contraction of the HDPE pipe. The minimum length of restrained pipe required shall be as shown on the contract drawings or as specified in Special Procedures - Division 01. If no minimum length for restrained joints is specified, the Contractor shall submit the restrained joint calculations to the Engineer for review prior to construction.

E. Restrained joint fittings shall be used in conjunction with concrete buttresses. When restrained joint fittings are used, a sufficient length of pipe on each side of the fitting shall be restrained to resist the thrust forces. The minimum length of restrained pipe required shall be as shown on the contract drawings.

F. Thrust restraint is not required for HDPE water mains with HDPE fittings except where transitioning to other pipe materials.

3.13 Disinfection and Bacteriological Testing

A. Before being placed in service, the entire line shall be flushed and chlorinated in accordance with the requirements of AWWA C651.

B. During the chlorination process, operate all valves, hydrants and accessories to ensure contact of all parts with the chlorine solution.

C. After chlorination, the water shall be flushed from the system at its extremities until the chlorine concentration in the water leaving the mains is no higher than that generally prevailing in the system or less than 1 mg/l.

D. After final flushing and before the water mains are placed in service, bacteriologically safe tests must be obtained. Two samples, at least 24 hours apart, are required. Sample in accordance with the requirements of AWWA C651.

E. No separate payment will be made for the disinfection and bacteriological testing. The cost shall be included in the pipe installation items.

3.14 Service Connections

A. Corporation stops for water service connections shall be placed to service each building site as required. The minimum water service size is 1-inch.

B. Unless otherwise noted, construct copper service laterals to the property line. Set the curb stop and box at the property line. The lateral shall have a minimum 7.0 feet of cover.

C. Installation
1. Install copper service with 7.0 feet of cover.
2. Locate service taps at the 10:00 or 2:00 o'clock positions on the circumference.
3. Service taps shall be at least 12 inches apart. Stagger taps around circumference when more than one tap is made at same location.
4. Prior to installation of corporation stop, wrap threads with two wraps of 3 mil Teflon tape.
5. Provide a horizontal half loop in the service pipe at the tap.

D. Water service laterals 2 1/2-inch diameter and larger shall have a minimum center-to-center horizontal separation of 8 feet from sewer laterals or mains.

E. Water service laterals 2-inch diameter and smaller shall have a minimum center-to-center horizontal separation of 30 inches from sewer laterals or mains. Separation may be less than 30 inches if the bottom of the water lateral is at least 12 inches (outside pipe to outside pipe) above the sewer lateral or main.

F. Service Saddles: All taps for PVC water main require a service saddle. Two inch taps on 6-inch ductile iron water main require a service saddle.

3.15 Setting Valves

A. Valves in water mains shall be provided and installed in locations as shown on the contract drawings. A valve box and valve box adaptor shall be provided for every valve unless otherwise specified. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the wrench nut of the valve. The box cover shall be flush or up to a 1/2 inch lower than the surface of the finished pavement.

B. HDPE by mechanical joint adapters must be used at all valves installed on HDPE16 pipe.

3.16 Setting Hydrants

A. Hydrants shall be located as shown on the contract drawings or as directed by the Engineer. All hydrants shall stand plumb and shall have the pumper nozzle facing the curb. Hydrants shall be set to the established grade, which shall be hereinafter considered as with nozzles at least 18 inches above the ground such that the following one or more conditions apply:
   1. Nozzle center is 18-24 inches above the top of proposed curb.
   2. Nozzle center is 18-24 inches above the existing ground line.
   3. Nozzle center is 18 inches above the proposed ground surface elevation for that hydrant location.

   The above hydrant vertical placement may be accomplished by adding hydrant extensions. The unit price bid for the hydrant shall include the cost of extensions.

B. All hydrant drainport shall be plugged in the following conditions:
   1. Hydrant drainport would be installed below groundwater table.
   2. Hydrant is placed in area with known soil contamination.
   3. Soil materials and coloration indicate groundwater may be above hydrant drainport.
   4. Plugging is shown on the contract drawings or is directed by the Engineer the field.

C. Wherever a hydrant is set in soil that is pervious, drainage shall be provided at the base of the hydrant by placing coarse gravel or crushed stone mixed with coarse sand, from the bottom of the trench to at least 6 inches above the waste opening in the hydrant and to a distance of 1 foot around the elbow. The drainage material shall be wrapped with non-woven geotextile fabric Type SAS conforming to the requirements of Geosynthetics for Earthwork - Division 31 of these specifications.

D. Wherever a hydrant is set in clay or other impervious soil, drainage shall be provided at the base of the hydrant by placing compacted coarse gravel or compacted crushed stone mixed with coarse sand, under and around the elbow of the hydrant to a level of 6 inches above the waste opening in the hydrant and to a distance 3 feet along the trench back toward the main.

E. All hydrants shall be constructed with a minimum of seven feet (7’-0”) of **c**over over the lead, or as shown on the contract drawings. and be set on a solid concrete block.

F. All hydrants shall be installed with thrust restraint utilizing concrete buttresses and 14 joint restraint, see thrust restraint this section.

3.17 As-Built Measurements

A. Provide as-built measurements clearly marked on a clean copy of the Construction Drawings. These as-built measurements are incidental to the Work. As a minimum, include the following items:
   1. Distance between valves, tees and bends.
   2. Ties from ground features to tees and bends to clearly located the buried utility construction.
   3. Distance from tees, valves, or bends to corporation stops.
   4. Length of service laterals.

END OF SECTION

SECTION 33 31 00

SANITARY SEWER CONSTRUCTION

PART 1 - GENERAL

1.01 Section Includes

A. Furnishing, installation, and testing of sanitary sewers.

B. Furnishing and installation of service laterals.

1.02 Related Sections

A. Section 31 23 33 - Utility Excavation, Backfill and Compaction.

B. Section 33 05 26 - Tracer Wire.

C. Section 33 39 13 - Sewer Manholes.

1.03 References

A. ASTM A74 - Cast Iron Soil Pipe and Fittings.

B. ASTM A746 - Ductile Iron Gravity Sewer Pipe.

C. ASTM C12 - Installing Vitrified Clay Pipe Lines.

D. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

E. ASTM D698 - Test Methods for Moisture - Density Relations of Soil and Soil-Aggregate Mixtures, Using 5.5 lb (2.49 kg) Rammer and 12-inch (304.8 mm) Drop.

F. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

G. ASTM D2321 - Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

H. ASTM D2487 - Clarification of Soils for Engineering Purposes.

I. ASTM D2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

J. ASTM D2665 - Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

K. ASTM D2855 - Recommended Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

L. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

M. ASTM D3212 - Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

N. ASTM F402 - Safe Handling of Solvent Cements Used for Joining Thermoplastic Pipe and Fittings.

O. ASTM F679 - Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.

P. ASTM F1417 - Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.

Q. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.

R. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water and Other Liquids.

S. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe 4-inch through 12-inch, for Water

Distribution

1.04 Submittals

A. Submit manufacturers' product literature for pipe, joints, and fittings.

B. Submit as-built measurements.

1.05 Quality Assurance

A. All pipes and fittings shall be new and unused.

B. Each length of pipe shall be clearly marked with the manufacturer's name, the type of pipe, and the pipe class.

C. Provide at least one person thoroughly trained and experienced in the skills required, who shall be completely familiar with the work described in this section, who shall be present at all times during progress of the work of this section, and who shall direct all work performed under this section.

D. Infiltration/exfiltration testing required.

E. Deflection testing of PVC pipe required.

PART 2 - PRODUCTS

2.01 Sewer Pipe

A. PVC
   1. 15" Diameter and Less: ASTM D3034, SDR-35.
   2. 18" Diameter and Greater: ASTM F679, SDR-35.
   3. Elastomeric joints, ASTM D3212, approved by the Wisconsin Department of Natural Resources.

B. Ductile Iron: ASTM A746 or AWWA C151, Class 50; cement-mortar lined; mechanical joints or push-on joints, AWWA C111.

2.02 Sewer Pipe - Water Main Quality

A. Use only when indicated on Drawings.

B. Ductile Iron: AWWA C151, Class 52; cement-mortar lining; ASTM C104; with flexible restrained joints capable of being deflected 4 degrees after assembly. Provide Griffin Snap-Lok pipe or equal.

C. PVC: AWWA C900, Class 150 (DR-18) with cast iron O.D.; rubber gasket joints.

2.03 Service Laterals

A. PVC: ASTM D3034, SDR-35, ASTM D2665 or ASTM D1785, Schedule 40; elastomeric joints, ASTM D3212 or solvent cement.

B. Cast Iron Soil Pipe: ASTM A74, service weight; elastomeric joints, ASTM C564.

2.04 Pipe Connections to Existing Pipe

A. Strong Back Fernco unless PVC to PVC, then use PVC elastomeric sleeve.

2.05 Bedding and Cover Material - Rigid Pipe (Ductile Iron and Cast Iron)

A. Bedding

1. Class B - Crushed Stone: Hard durable particles of crushed stone or gravel, free from shale and lumps of clay or loam, conforming to the following gradation:

Sieve Size	% Passing By Weight
1”	100
3/4”	90 - 100
3/8”	20 -55
No. 4	0 - 10
No. 8	0 - 5
No. 200	0 - 5

2. Class C - Excavated soils listed in ASTM D2487 as the following are acceptable:
   GW - Well-graded gravels, gravel-sand mixtures, little or no fines.
   GP - Poorly-graded gravels, gravel-sand mixtures, little or no fines.
   GM - Silty gravels, gravel-sand-silt mixtures.
   GC - Clayey gravels, gravel-sand-clay mixtures.
   SW - Well-graded sands, gravelly sands, little or no fines.
   SP - Poorly-graded sands, gravelly sands, little or no fines.
   SM - Silty sands, sand-silt mixture.
   SC - Clayey sands, sand-clay mixtures.

   Excavated soils listed in ASTM D2487 as the following are not acceptable:
   ML - Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
   CL - Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
   OL - Organic silts and organic silty clays of low plasticity.
   MH - Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
   CH - Inorganic clays of high plasticity, fat clays.
   OH - Organic clays of medium to high plasticity, organic silts.
   Pt - Peat and other highly organic soils.

   If excavated material is unsuitable, use Class B material.

B. Cover: Cover material shall be finely divided material free of debris, organic material and large stones.

2.06 Bedding and Cover Material - Flexible Pipe (PVC)

A. Bedding and Cover: Provide offsite bedding and cover material meeting the requirements of ASTM D2321, Class IA, IB, II or III material, which materials are described as follows:

1. Class IA - Clean angular crushed stone, crushed rock, or crushed gravel conforming to the following gradation:

Sieve Size	% Passing By Weight
1”	100
3/4”	90 - 100
3/8”	20 -55
No. 4	0 - 10
No. 8	0 - 5

2. Class IB - Clean angular crushed stone, crushed rock, or crushed gravel conforming to the following gradation:

Sieve Size	% Passing By Weight
1/2”	100
3/8”	85 - 100
No. 4	10 - 30
No. 200	0 - 5

3. Class II - Clean coarse-grained soils with 100% passing the 1-1/2” sieve and less than 5% passing the No. 200 sieve. Generally including sands, gravels, and sand-gravel mixtures with little or no fines. ASTM D2487 Soil Types GW, GP, SW and SP are included in this class.

4. Class III - Coarse-grained soils with fines with 100% passing the 1-1/2” sieve and 12% - 50% passing the No. 200 sieve. Generally includes silty or clayey sands, gravels, or sand-gravel mixtures. ASTM D2487 Soils Types GM, GC, SM and SC, are included in this class.

5. If the excavated material conforms to one of the bedding classes, it may be used for bedding.

PART 3 – EXECUTION

3.01 Handling of Pipe

A. All pipes and accessories shall be handled with care to avoid damage. Pipe and accessories shall not be dropped or dumped.

B. All material found to have cracks or flaws shall be removed from the job site.

C. Contractor is responsible for arranging suitable sites for material storage.

3.02 Lines and Grades

A. The use of a laser beam for maintaining line and grade is required unless other methods are approved by the Engineer or Owner’s Representative. Check elevations of all sewers with a level every 50 feet where the grades are equal to or less than one percent and every 100 feet where the grades are greater than one percent.

B. A person qualified to operate the equipment shall be present when the laser is in use.

3.03 Laying Pipe

A. Lay pipe uniformly to line and grade so that the finished sewer will have a smooth and uniform invert. Noticeable variations from true alignment and grade will be sufficient cause for the rejection of the work.

B. Proceed upgrade, with the spigot ends pointing in the direction of flow.

C. Pipe shall be laid so that each pipe rests on the full length of its barrel.

D. Do not lay next pipe until previous pipe is backfilled sufficiently to prevent movement.

E. All pipe laid in trenches shall have a minimum clearance or 6 inches for rigid pipe and 12 inches for flexible pipe between the outside face of the pipe and the trench wall.

F. For flexible pipe do not disturb the installed pipe and its embedment when using movable trench boxes. If the box extends below the cover material, use methods to assure that the integrity of the embedment is maintained when the box is moved.

G. Keep interior of the pipe clean and dry. Water shall not be allowed in the trench while pipe is being laid. When work is stopped, securely plug the end of the pipe.

H. Joining Pipe: Assemble joints in accordance with the pipe manufacturer’s instructions. Solvent cements shall meet ASTM D2564 as applicable. Make PVC solvent cement joints in accordance with ASTM D2855. Handle solvent cements in accordance with ASTM F402.

I. Trench excavations shall be fully completed a sufficient distance in advance of the laying of the sewer, and the exposed end of all pipes shall be fully protected with a board or other approved stopper to prevent earth or other substances from entering the pipe. Not more than 100 feet of trench shall be opened in advance of pipe laying unless permitted by the Engineer.

3.04 Rigid Pipe Bedding and Cover

A. Pipe bedding and cover shall conform to Classes B or C. Unless otherwise indicated on the

Drawings, use Class C.

B. Bedding material shall be spaded or shovel sliced so that the material fills and supports the haunch area of the pipe.

C. Cover material shall be placed and worked by hand.

3.05 Flexible Pipe Bedding and Cover

A. Pipe bedding and cover shall be Class IA, IB, II or III materials unless the bedding class is indicated on the Drawings. Do not use Class II or Class III material when there is water in the trench. Use the same material for bedding and cover.

B. Place bedding material below and around pipe to the spring line to provide side support and to prevent lateral and vertical movement of the pipe. Place Class IA and Class IB material in maximum 6-inch layers. Place and compact Class II and Class III material in maximum 6-inch layers. Work the material in and around the pipe by hand to provide uniform support.

C. Place cover material to a level 6 inches above the top of the pipe. Place Class IA material in maximum 6-inch layers. Place and compact Class IB, Class II, and Class III materials in maximum 6-inch layers. Class IA material shall be worked by hand. Class IB material shall be compacted using hand tampers or vibratory compacters. Class II and Class III material shall be compacted using vibratory compactors. Each stage shall be compacted by hand or mechanical tamping to the percent of the maximum dry density in accordance with ASTM D698 as indicated below:

Required Density

Material	Density
Class 1A	None
Class 1B	85%
Class II	85%
Class III	90%

3.06 Backfilling

A. Backfill in accordance with the Section 31 23 33.

3.07 Separation from Water Main

A. Sanitary sewer mains shall be placed at least 8 feet horizontally (center to center) from any existing or proposed water main. If, due to ledge rock conditions or physical barriers, the Engineer determines that the 8-foot horizontal separation cannot be maintained, the horizontal separation may be reduced to a minimum of 3 feet if the bottom of the water main is at least 18” above the top of the sewer.

B. When sanitary sewer mains cross under water mains, provide a minimum separation of 6 inches from the bottom of the water main to the top of the sewer. When sanitary sewer mains cross over water mains, provide a minimum of 18 inches from the bottom of the sewer to the top of the water main.

C. If an existing water main is encountered while laying the sanitary sewer and it is impossible to obtain the proper vertical separation, immediately inform the Engineer and reconstruct the water main for a minimum distance of 8 feet on either side of the sanitary sewer to permit centering one full length of water main over the sanitary sewer.

3.08 Infiltration/Exfiltration Testing

A. Test all sewers for infiltration/exfiltration. Either the water infiltration test or the low pressure air test may be used. Provide all materials, equipment and labor necessary to conduct the tests. Include the cost of testing in the price bid for the sewer. Perform tests under the observance of the Engineer or authorized representative of the Owner.

B. The Contractor shall furnish all of the equipment necessary for conducting the test, and all tests shall be conducted in the presence of the Engineer and/or inspector.

C. Water Infiltration Test

1. The rate of infiltration of water into the sewers including appurtenances shall not be greater than 200-gallons per day per inch per mile. Infiltration between any two adjacent manholes shall not be greater than 500-gallons per day per inch diameter per mile.

Allowable Limits of Infiltration
200 Gal/Day/In.-Diam/Mile

Diameter of Sewer (Inches)	Infiltration Per 100' Per Hr. (Gallons)
4"	0.63
6"	0.95
8"	1.26
10"	1.58
12"	1.90
15"	2.37
18"	2.84
48" I.D. MH	0.08 Gal/Vf/Hr

2. Tests for infiltration/exfiltration shall be conducted in a manner approved by and under the direction of the Engineer and shall be performed with a minimum positive head of 2 feet.

D. Low Pressure Test

1. Conduct test in accordance with ASTM F1417.
2. Procedure:
   a. Clean and flush line to be tested.
   b. Determine test time for the section of line to be tested using Table 1.
   c. Plug all openings in test section.
   d. Add air until the internal pressure of the line is raised to 4.0 psi. Allow air pressure to stabilize (usually 2-5 minutes). Maintain a minimum pressure of 3.5 psi.
   e. When pressure is stabilized, reduce pressure to the starting pressure of 3.5 PSI. If the pressure drops more than 1.0 PSI during the minimum test time indicated in Table 1, the line is presumed to have failed.
   f. For larger pipe, the Engineer may, at his discretion, use the minimum test times for a 0.5 psi pressure drop indicated in Table 2.
   g. If the test section is below the groundwater level, determine the height of groundwater above the spring line of the pipe at each end of the test section and compute the average. For every foot of groundwater above the spring line of the pipe, increase the test pressure by 0.43 psi.

Table 1 - Minimum Specified Time Required for a 1.0 PSI Pressure Drop for Size and Length of Pipe Indicated

Pipe Diam. in.	Minimum Time, min:s	Length For Minimum Time, ft.	Time For Longer Length	Specified Time for Length (L) Shown, min:s						
				100'	150'	200'	250'	300'	350'	400'
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36
18	17:00	133	7.694 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10

Table 2 - Minimum Specified Time Required for a 0.5 PSI Pressure Drop for Size and Length of Pipe Indicated

Pipe Diam. in.	Minimum Time, min:s	Length For Minimum Time, ft.	Time For Longer Length	Specified Time for Length (L) Shown, min:s						
				100’	150’	200’	250’	300’	350’	400’
4	1:53	597	0.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427 L	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54
12	5:40	199	1.709 L	5:40	5:40	5:42	7:08	8:33	9:58	11:29
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35

3.09 TV Inspection

A. TV inspection shall be used in lieu of air testing for sewer replacement projects that have live lateral connections connected to the new sewer main. If there is no bid item for the TV inspection, the cost of the inspection is incidental to the sewer construction.

B. TV inspection may be required on all sewer mains and on all sewer laterals. If TV inspection is required it will be noted on the Drawings or elsewhere in the Bidding Documents. If there is no bid item for the TV inspection, the cost of the inspection is incidental to the sewer construction.

C. The Engineer reserves the right to require TV inspection if there is reason to believe that there has been settlement of the pipe.

D. Required TV inspection shall be performed after construction of the sewer main and laterals has been completed but prior to paving. Any defects found shall be repaired. Two copies of the TV report shall be submitted to the Engineer with a copy of the televising on DVD. The report shall include a summary of all defects and the location of all laterals.

3.10 Deflection Testing

A. Deflection tests shall be performed on all PVC mainline sewer pipe.

B. The test will be performed with a rigid ball or mandrel without mechanical pulling devices. The testing device must pass freely through the pipe without the use of excessive force. Any line which does not pass the testing device will not be accepted until the faulty pipe is replaced and the line re-tested.

C. If deflection testing is done within 30 days after backfilling, deflection may not exceed 5%. If deflection testing is done more than 30 days after backfilling, deflection shall not exceed 7.5%. See following table for mandrel dimensions for ASTM D3034 and ASTM F679, SDR-35 PVC pipe.

Mandrel Dimensions for SDR-35 PVC Pipe			
Nominal Size In.	Base Inside Diameter*	7 ½% Mandrel	5% Mandrel
8	7.665	7.09	7.28
10	9.653	8.84	9.08
12	11.361	10.51	10.79
15	13.898	12.86	13.20
18	16.976	15.70	16.13
21	20.004	18.50	19.00

24	22.480	20.80	21.36
27	25.327	23.44	24.06

* As per ASTM D3034 and F679

The costs of all deflection testing shall be included in the unit price bid for that section of sewer. No additional payment will be allowed for testing or re-testing of sewer.

3.11 Final Sewer Cleaning

A. Prior to final acceptance the sewer main shall be jet-vacuumed. Unless the Engineer indicates a different time, the sewer cleaning shall be performed after the asphalt pavement has been placed. If not listed as a separate bid item, the cleaning is incidental to the sanitary sewer construction.

3.12 Service Laterals

A. Fittings shall be wyes on sewers less than 12-inch diameter. On sewers 12-inch diameter or larger, tees may be used.

B. For sewer replacement projects with existing service laterals, wyes or tees shall be 6-inch unless the Contractor field verifies that the existing lateral is 4-inch from the main to the building. For 4-inch laterals, a 6x4 reducer will be required. Connect to existing pipe with a solid back Fernco (solid metal band) – Strong Back by Fernco Inc. or equal.

C. All wyes and tees without laterals and the ends of all service laterals shall be sealed with solvent cemented caps.

D. Unless otherwise indicated, all laterals shall extend to the property line.

E. The depth or elevation of the lateral at the property line may be set by the Engineer. If not set by the Engineer, verify lateral depths with the Engineer when the depths at the property line are less than eight feet or more than ten feet deep.

F. The lateral shall be laid with a minimum slope of 1/8” per foot and a maximum slope of 1/2” per foot. Risers laid at 45 degrees shall be used to keep the pipe within the maximum slope limit.

G. Sewer and Water Lateral Separation
   1. Sewer laterals shall have a minimum center-to-center horizontal separation from water service laterals 2-inch diameter and smaller of 30 inches. Separation may be less than 30 inches if the bottom of the water lateral is at least 12 inches above the sewer lateral.
   2. Sewer laterals shall have a minimum center-to-center horizontal separation from water service laterals 2-1/2 diameter and larger of 8 feet.

H. The sewer lateral shall be laid no closer than 8 feet to a well.

I. Saddle wyes added to existing sewer mains shall be PVC. Fernco style shall not be allowed.

3.13 Tracer Wire

A. Furnish and install tracer wire for PVC sewer laterals in accordance with Section 33 05 26.

3.14 As-Built Measurements

A. Provide as-built measurements clearly marked on a clean copy of the Construction Drawings. These as-built measurements are incidental to the Work. Include measurements for all laterals including distance from downstream manhole to wye or tee, length of lateral, height of riser, invert elevations of manholes, and invert elevation of lateral.

END OF SECTION

SECTION 33 39 13

SEWER MANHOLES AND INLETS

PART 1 - GENERAL

1.01 Section Includes

A. Precast concrete manholes for sanitary and storm sewer construction.

B. Cast-in-place concrete manholes shall be provided only when indicated on the Drawings.

1.02 References

A. ASTM A48 - Gray Iron Castings.

B. ASTM C94 - Specification for Ready-Mixed Concrete.

C. ASTM C270 - Mortar for Unit Masonry.

D. ASTM C478 - Precast Reinforced Concrete Manhole Sections.

E. ASTM 877 - Standard Specifications for External Sealing Bands for Concrete Pipe, Manholes and Precast Box Sections.

F. ASTM C923 - Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

G. ASTM C990 - Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

H. AASHTO M198 - Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets.

1.03 Quality Control

A. Manhole section will be rejected for any of the following reasons:
   1. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.
   2. Surface defects indicating honey-combed or open texture that would adversely affect the function of the manhole.
   3. The planes of the ends of the manhole sections are not perpendicular to their longitudinal axis, within the limits of the variation given in paragraphs 12.3 and 12.4 of ASTM C478.
   4. Damaged or cracked ends, where such damage would prevent making a satisfactory joint.
   5. Any continuous crack having a length of 12 inches or more, regardless of position in the section of wall.
   6. Lift holes that extend through wall.
   7. Drop across flowline not as specified.

B. HDPE adjusting rings will be rejected if they contain cracks that extend more than one-half the thickness of the ring.

PART 2 - PRODUCTS

2.01 Manholes and Inlets

A. Precast concrete, ASTM C478.
   1. Standard manhole shall have a 48-inch inside diameter, eccentric cone and 24-inch diameter opening, unless indicated otherwise on the Drawings. Inlets shall be the size and configuration as shown on the Drawings.
   2. Provide slab tops when manholes are too shallow for cone section. Slab tops shall be of the in-bell design.
   3. Lift holes extending through barrel wall are not allowed.

C. Steps: ½ inch diameter, Grade 60 steel rod covered with polypropylene plastic; PS1, M.A. Industries, Inc. ML-10, American Step Company; or equal.

D. Pipe Connections to Structures:
   1. Sanitary Sewer: Flexible, watertight, rubber connector; Kor-N-Seal, NPC, Inc.; PSX, Press-Seal Gasket Corp; or equal.
   2. Storm Sewer: Ready-mix concrete collar. Minimum of 6" of concrete around the entire circumference of the pipe at the structure exterior and flush with the structure interior filling all voids/cavities. No mortar will be allowed.

2.02 Castings

A. Cast iron, ASTM A48, Class 35B.

B. Manufacturer: Neenah Foundry Co. or equal.

C. Sanitary Sewer Manhole: Non-rocking design, concealed pick holes and neoprene O-ring gasket, unless otherwise indicated in the Contract Documents.

D. Storm Sewer Manhole/Inlets: Provide frames, solid lids, and grates as indicated in the Contract Documents.

2.03 Manhole Seals

A. Joint Sealant: Pre-formed, butyl rubber, AASHTO M198 or ASTM C990; Kent Seal, Hamilton Kent; EZ-Stik, Press-Seal Gasket Corp.; ConSeal; or equal.

B. Exterior Joint Sealant: A rubberized external sealing collar with metal bands meeting ASTM C877, Type II; MacWrap by MarMac Manufacturing Co. or equal.

C. Interior/Exterior Manhole Chimney Seal:
   1. A flexible interior/exterior seal designed to prevent leakage of water throughout a 20-year design life. The seal shall remain flexible throughout the design life, allow repeated vertical movements of the frame of not less than two inches and/or repeated horizontal movement of not less than one-half inch. Includes EPDM rubber sleeve, stainless steel clamp and band, butyl mastic, and recycled rubber ring.
   2. Manufacturer: Adaptor Inc., West Allis, WI; or equal.

2.05 HDPE Adjusting Rings – Manholes

A. Adjusting rings shall be injection molded High Density Polyethylene (HDPE) adjustment rings as manufactured by Ladtech, Inc., Lino Lakes, MN, or equal. Install HDPE adjusting rings per the manufacturer recommendations.

B. The first HDPE adjusting ring shall be bolted to the top of the manhole cone with a minimum of three (3) bolts. Install the following HDPE adjusting rings with a butyl rope sealant between each ring and between the top ring and the frame.

2.06 Adjusting Rings – Curb Inlets

A. Precast concrete, uniform in dimension, with smooth surfaces.

B. Rectangular adjusting rings shall be complete rectangles. L-shaped rings are not acceptable.

C. Cracked or otherwise damaged rings shall not be used.

D. Concrete: ASTM C94; 3,000 psi at 28 days, 3 to 4-inch slump, maximum aggregate size of 1-1/2 inch.

E. Mortar: ASTM C270, Type M.

2.07 Accessory Materials

A. Hard, durable particles of crushed stone or gravel, substantially free from shale or lumps of clay or loam, meeting the following gradation:

Sieve Size	Percent Passing by Weight
2-inch	100
1-1/2 -inch	90-100
1-inch	20-55
3/4-inch	0-15
1/2-inch	0-5

PART 3 - EXECUTION

3.01 General

A. Provide 4 to 6 inches of HDPE adjusting rings for sanitary sewer manholes, 2 to 4 inches of HDPE adjusting rings for storm sewer manholes, and 2 to 4 inches of concrete adjusting rings for curb inlets, unless otherwise indicated.

B. Limit the manhole/inlet excavation to the size required for installation. Provide bracing and sheathing as necessary.

C. Provide 6 inches of crushed stone under the manhole or inlet base.

D. Install manhole or inlet plumb.

3.02 Joint Sealing

A. Seal joints with butyl rubber rope.

B. When the manhole joints are below the groundwater elevation, the manhole joints shall be sealed on both the edges of the joint with butyl rubber rope and an external joint seal.

3.03 Flow Channel and Bench

A. Provide a U-shaped flow channel, depth equal to two-thirds the diameter of incoming and outgoing pipe but not less than 6”. The channel shall be steel troweled to a smooth finish and be a continuation of the pipe.

B. No horizontal surfaces shall be left on the inside of the manhole floor. The bench shall have a minimum slope of 2” from the side of the manhole to the channel. The surface shall be troweled to a smooth but non-slip finish.

C. Precast channels and benches for sanitary sewer manholes are preferred.

3.04 Steps

A. Locate steps over outgoing pipe.

B. Place steps in vertical alignment, equally spaced at 16” C-C with the top step not more than 24” from the top of the casting.

3.05 Setting Frames and Rings

A. Set frame and cover at the required elevation.

B. In paved areas set manhole rim one-half inch below finish grade. Set the tops of the manholes to the same slope as the surrounding pavement.

C. Prior to setting the manhole frame casting, clean surface of manhole chimney section and cast iron frame of all foreign materials and moisture.

D. Final adjustment of frames shall be done after curb and gutter has been constructed, the base course has been placed, and the finished pavement elevation and slope is known.

3.06 Installation of Interior/Exterior Manhole Chimney Seal

A. Install seal in accordance with the manufacturer's instructions.

B. Seal shall extend from casting to manhole section, covering the entire ring section.

C. Install the interior/exterior manhole seal in the presence of the engineer after all layers of the asphalt pavement has been installed.

3.07 Outside Drop

A. Provide an outside drop pipe for any sanitary sewer pipe whose invert is more than 2 feet above the manhole invert.

B. The invert of the drop pipe shall enter the manhole at the elevation indicated on the Drawings or at the spring line of the outgoing sewer if no elevation is provided.

C. The drop pipe shall be strapped to the manhole and encased in concrete per the standard detail on the Drawings or the drop may be precast integral to the manhole barrel section (preferred).

END OF SECTION

SECTION 33 41 13

STORM SEWER CONSTRUCTION

PART 1 - GENERAL

1.01 Section Includes

A. Construction of storm sewer.

B. Construction of storm manholes and inlets.

1.02 Related Sections

A. Section 31 23 33 - Utility Excavation, Backfill and Compaction.

B. Section 33 39 13 - Sewer Manholes.

1.03 References

A. ASTM A48 - Standard Specification for Gray Iron Castings.

B. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

C. ASTM A760 - Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.

D. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.

E. ASTM C94 - Standard Specification for Ready-Mixed Concrete.

F. ASTM C270 - Standard Specification for Mortar for Unit Masonry.

G. ASTM C443 - - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

H. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.

I. ASTM C506 - Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe.

J. ASTM C507 - Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe.

K. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).

L. ASTM A929 - Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe.

M. ASTM D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

N. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

O. ASTM F2736 - Standard Specification for 6 to 30 in. (152 to762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe.

P. ACI 304 - Recommended Practice for Measuring, Transporting, and Placing Concrete.

Q. ACI 347 - Recommended Practice for Concrete Formwork.

1.04 Submittals

A. Submit product data for pipe and accessories.

B. Submit bedding gradation if requested.

C. Submit as-built measurements.

1.05 Quality Assurance

A. All pipes and fittings shall be new and unused.

B. Provide at least one person thoroughly trained and experienced in the skills required, who shall be completely familiar with the work described in this section, who shall be present at all times during progress of the work of this section, and who shall direct all work performed under this section.

PART 2 - PRODUCTS

2.01 Pipe

A. Reinforced Concrete (RCP)
   1. Pipe: ASTM C76, ASTM C506, or ASTM C507. Provide Class III unless otherwise indicated on the Drawings or in the Specifications.
   2. Joints
      a. Circular Pipe: Tongue and groove with rubber gaskets, ASTM C443.
      b. Elliptical and Arch Pipe: Tongue and groove with cold plastic sewer joint compound or tongue and groove with external sealing collar, MacWrap or equal.

B. Corrugated Steel (Use only when indicated on Drawings)
   1. Galvanized Pipe:
      a. Material: Galvanized steel coil, ASTM A929.
      b. Pipe: Manufactured in accordance with ASTM A760, Type I or II.
   2. Aluminized Pipe:
      a. Material: Aluminized Type 2 steel coil, ASTM A929.
      b. Pipe: Manufactured in accordance with ASTM A760, Type I or II.
   3. Joints: Matching bond connectors.
   4. Minimum Pipe Gauge:

Minimum Pipe Gauge			
Pipe Diameter	2-2/3" x 1/2" Corrugations	Pipe Diameter	3" x 1" Corrugations
6"	18	60" - 90"	16
8" - 24"	16	96" - 102"	14
30" - 36"	14	108" - 114"	12
42" -54"	12	120"	10
60" - 72"	10		
78" - 98"	8		

C. Corrugated Polyethylene (Use only when indicated on Drawings.)
   1. Smooth interior, with annular exterior corrugations meeting requirements of ASTM F2736.
   2. Joints: Gasketed integral bell and spigot meeting requirements of ASTM F2736. Joints shall be watertight in accordance with ASTM D3212. Gaskets shall meet the requirements of ASTM F477.
   3. Fittings: Polyethylene fittings meeting requirements of ASTM F2736.
   4. Acceptable Manufacturers: ADS N-12 HP or equal.

2.02 End Sections

A. Manufacturer's standard product.

B. Provide concrete for concrete pipe and corrugated metal for steel pipe or polyethylene pipe.

2.03 Pipe Bedding and Cover

A. Bedding and Cover:

   1. Class IA - Clean angular crushed stone, crushed rock, or crushed gravel conforming to the following gradation:

Sieve Size	% Passing By Weight
1”	100
3/4”	90 - 100
3/8”	20 -55
No. 4	0 - 10
No. 8	0 - 5

2. Class IB - Clean angular crushed stone, crushed rock, or crushed gravel conforming to the following gradation:

Sieve Size	% Passing By Weight
1/2”	100
3/8”	85 - 100
No. 4	10 - 30
No. 200	0 - 5

3. Class II - Coarse-grained soils free from organic matter, trash, debris, and frozen material with 100% passing the 1-1/2” sieve and less than 5% passing the No. 200 sieve. Generally including sands, gravels, and sand-gravel mixtures with little or no fines. ASTM D2487 Soil Types GW, GP, SW and SP are included in this class. Excavated material may be used if it meets the above material requirements.

4. Class III - Coarse-grained soils with fines free from organic matter, trash, debris, and frozen material with 100% passing the 1-1/2” sieve and 12% - 50% passing the No. 200 sieve. Generally includes silty or clayey sands, gravels, or sand-gravel mixtures. ASTM D2487 Soils Types GM, GC, SM and SC, are included in this class. Excavated material may be used if it meets the above material requirements.

2.04 Manholes and Inlets

A. General
1. Precast concrete manholes and inlets (and castings) shall meet requirements of Section 33 39 13 with the exceptions noted.
2. Exterior/interior manhole seals are not required.
3. Structure pipe connection shall be constructed using ready-mix concrete collars with a minimum of 6” of concrete around the entire circumference of the pipe at the structure exterior and flush with the structure interior filling all voids/cavities. No mortar will be allowed.
4. Concealed pickhole covers are not required.

B. Cast-In-Place Concrete
1. Ready-mixed concrete meeting requirements of ASTM C94; 3000 psi 28-day strength, 3 to 4-inch slump, maximum aggregate size of 1-1/2 inch and air entrainment of 7 percent.
2. Reinforcing steel: ASTM A615, Grade 60.

C. Crushed Stone: Hard durable particles of crushed stone or gravel substantially free from shale or lumps of clay or loam meeting the following gradation:

Sieve Size	% Passing By Weight
2”	100
1-1/2”	90 - 100
1”	20 - 55
3/4”	0 - 15
1/2”	0 - 5

PART 3 - EXECUTION

3.01 Handling of Material

A. All materials shall be handled with care to avoid damage. No material shall be dropped.

B. All defective material shall be removed from the job site.

C. Contractor is responsible for arranging suitable sites for material storage.

3.02 Lines and Grade

A. All pipe shall be laid to the lines and grades shown on the drawings or given by the Engineer.

B. The use of a laser beam for maintaining line and grade is required unless other methods are approved by the Engineer.

C. A person qualified to operate the equipment shall be present when the laser is in use.

3.03 Laying Pipe

A. Lay pipe uniformly to line and grade so that the finished sewer presents a uniform bore. Noticeable variations from true alignment and grade will be sufficient cause for rejection of the work.

B. Commence at the lowest point and proceed to the upper end. Lay pipe with bell-end pointing up-grade.

C. For reinforced concrete pipe provide a minimum of six inches between the pipe wall and the trench wall. For polyethylene and corrugated steel pipe, provide a minimum distance between the pipe wall and the trench wall of 2.5 times the pipe diameter for poor or expansive soils and a minimum of 12 inches for all other soils.

D. Rest each pipe on the full length of its barrel.

E. Do not lay the next pipe until the previous pipe is backfilled sufficiently to prevent movement during joining.

F. For flexible pipe do not disturb the installed pipe and its embedment when using movable trench boxes. If the box extends below the cover material, use methods to assure that the integrity of the embedment is maintained when the box is moved.

G. Keep water out of the pipe. Do not let water rise into or around the pipe until the trench is filled at least one foot above the pipe.

H. When work is stopped for any reason, securely plug the end of the pipe.

I. Jointing: Assemble joints in accordance with the pipe manufacturer's instructions.

J. Do not drive over flexible pipe unless there is a minimum of 24 inches of cover material over the pipe.

3.04 Rigid Pipe Bedding - RCP

A. Pipe bedding and cover shall be Class IA, Class IB, Class II, or Class III. If pipe is in groundwater, bedding and cover shall be Class IA or IB. Use the same material for bedding and cover.

B. Place bedding material below and around pipe to the spring line to provide side support and to prevent lateral and vertical movement of the pipe. Place material in 6-inch maximum layers. Work the material in and around the pipe by hand to provide uniform support.

C. Place cover material to a level 6 inches above the top of the pipe.

3.05 Pipe Bedding - Polyethylene and Corrugated Steel

A. Pipe bedding and cover shall be Class IA or Class IB. If pipe is in groundwater, use Class IB.

B. Place bedding material below and around pipe to the spring line to provide side support and to prevent lateral and vertical movement of the pipe. Place Class IA and Class IB material in 6-inch maximum layers. Work the material in and around the pipe by hand to provide uniform support.

C. Place cover material to a level 12 inches above the top of the pipe. Place Class IA and Class IB

material in maximum 6-inch layers. Class IA material shall be worked by hand. Class IB material shall be compacted using hand tampers or vibratory compacters. Each stage shall be compacted by hand or mechanical tamping to the percent of the maximum dry density in accordance with ASTM D698 indicated below:

Material	Density
Class IA	None
Class IB	85%

D. Do not use a hydrohammer with less than 4 feet of cover over the pipe.

3.06 Backfilling

A. Backfill in accordance with the Section 31 23 33.

3.07 Manhole and Inlet Construction

A. Cast-In-Place: Cast-in-place manholes and inlets shall be constructed as shown on the Drawings. If cast-in-place manholes are not shown and the Contractor desires to provide them in lieu of precast concrete, Shop Drawings prepared by a qualified Engineer must be submitted for approval.

B. Construction
1. Provide two to four inches of precast adjusting rings unless otherwise indicated.
2. Manholes that are constructed when temperature is below 35°F shall be protected from freezing.
3. Limit the manhole excavation to the size required to install the manhole. Provide bracing and sheathing as necessary.
4. Provide six inches of crushed stone under the manhole base.
5. Precast manhole and inlet pipe connections shall be constructed using ready-mix concrete collars with a minimum of 6” of concrete around the entire circumference of the pipe at the structure exterior and flush with the structure interior filling all voids/cavities. No mortar will be allowed.
6. Inverts shall be the same size as the diameter of the largest adjoining pipe. Shape inverts in accordance with the Standard Drawings. Provide a smooth finish.
7. Provide tongue and groove joints sealed with butyl rubber rope for reinforced concrete barrel sections.
8. Construct cast-in-place structures in accordance with ACI 304 and ACI 347.
9. Frames and Covers: Provide frames and covers in the size and type indicated on the Drawings. Set rims of manholes and inlets at finish grade elevation. In paved areas set the rims one-half inch below the pavement surface. Set the rim to match the slope of adjacent paving. Perform final rim adjustment after base course has been placed.
10. Frame/Adjusting Ring Joints: Provide a mortar joint for manholes and field inlets. Dry stack adjusting rings on curb inlets and mortar casting to top ring at time of curb construction.
11. Provide steps for manholes and circular inlets that are 4-feet or more in depth and 4-feet in diameter and larger. Place steps in vertical alignment, equally spaced at 16” on-center with top step not more than 24 inches from top of casting.

3.08 End Sections

A. Provide flared end sections on all inlet and outlet ends of storm sewer that do not terminate within a manhole or inlet. Provide prefabricated grates on all end sections for pipes larger than 12-inch diameter. Provide riprap at discharge end as indicated on the drawings.

3.09 Separation from Water Main

A. Storm sewer mains shall be placed at least 8 feet horizontally (center to center) from any existing or proposed water main. If, due to ledge rock conditions or physical barriers, the Engineer determines that the 8-foot horizontal separation cannot be maintained. The horizontal separation may be reduced to a minimum of 3 feet if the bottom of the water main is at least 18” above the top of the sewer.

B. The vertical separation for storm sewer mains crossing under water mains shall be such that the elevation from the top of the sewer to the bottom of the water main is at least 6”. The vertical separation for storm sewer mains crossing over water mains shall be such that the elevation from

the bottom of the sewer to the top of the water main is a least 18”.

C. If an existing water main is encountered while laying the storm sewer and it is impossible to obtain the proper vertical separation, immediately inform the Engineer. Reconstruct the water main for a minimum distance of 8 feet on either side of the storm sewer to permit centering one full length of water main over the storm sewer.

3.10 As-Built Measurements

A. Provide as-built measurements clearly marked on a clean copy of the Contract Drawings. Tie location of bends and all connections not terminating with a manhole or inlet to ground features to clearly locate the buried construction. As-built measurements are incidental to the Work.

END OF SECTION