SECTION 22 13 13 - SANITARY SEWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings.
   2. Nonpressure and pressure couplings.
   3. Expansion joints and deflection fittings.
   4. Cleanouts.
   5. Encasement for piping.
   6. Manholes.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Expansion joints and deflection fittings.

B. Shop Drawings: Submit in accordance with Section 01 33 00 Submittals covering the items included under this Section. Shop Drawing submittals shall include:
   1. For manholes. Include plans, elevations, sections, details, and frames and covers.
   2. Shop Drawings shall be fully dimensioned Drawings showing the piping in full detail with exact locations, dimensions, and schedules of all pipe, fittings, hangers, supports, and appurtenances. They shall be made in accordance with the general information shown on Drawing and special information furnished by the several manufacturers of equipment. Where special fittings are required, they shall be shown in large detail with all necessary dimensions.
   3. Each pipe section, special fitting, casting, sleeve, and appurtenance shall be identified on Drawings by its respective erection mark.

C. Record Drawings: At Project closeout, submit record Drawings of installed products, in accordance with requirements of MHOG Standards.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with the Recommended Standards for Wastewater Facilities (Ten States Standard) Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight. Flexible pipe shall be stored on a flat surface so that barrel is evenly supported. Pipe shall not be stored in piles higher than 4 feet.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

C. Handle manholes according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

A. The drawings are not intended to show every detail of construction or location of piping or equipment. Where existing conditions make it necessary or advisable to change location of piping or equipment, Contractor shall inform Engineer for Engineer’s approval. Engineer shall be allowed 48 hours to respond to any discrepancy without being responsible for any delay in the Work.

B. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by public or private facilities unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
1. Do not proceed with interruption of service without the written permission of the Authority.

PART 2 - PRODUCTS

Refer to Part IV- Approved Procedures for a list of all approved products and materials.

2.1 REQUIRED MANUFACTURERS

A. Adapter Flange Coupling (AFC): Shall be the product of one of the following manufacturers, or equal:
1. Uni-Flange
2. Victaulic Co.
3. Smith-Blair, Inc.

B. Bolted Flexible Coupling (BFC): Shall be the product of one of the following manufacturers, or equal:
1. Dresser Industries, Inc.
2. Smith-Blair, Inc.

C. Equipment Connections: Shall be the product of one of the following manufacturers, or equal:
1. Garlock
2. Metra Flex
3. Mercer Rubber Co.
4. Redflex
5. Atlantic Metal Hose Co (Vibra-flexor)

6. Allied Metal Hose Co.
7. Universal Oil Products

D. Hangers and Supports: Shall be the product of one of the following manufacturers, or equal:
1. Grinnel
2. Elcen

E. Mechanical Sleeve Seals: Shall be the product of one of the following manufacturers, or equal:
1. Thunderline Corp.

2.2 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

A. Push-on-Joint Piping:
1. Pipe: AWWA C151 (NPS 3 to NPS 64). Thickness class 52 or Pressure class 350.
2. Standard Fittings: AWWA C110, ductile or gray iron (NPS 3 to NPS 48).
3. Compact Fittings: AWWA C153 (NPS 3 to NPS 64).
4. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.

B. Mechanical-Joint Piping:
1. Pipe: AWWA C151, with bolt holes in bell (NPS 3 to NPS 48).
2. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell (NPS 3 to NPS 48).
3. Compact Fittings: AWWA C153, with bolt holes in bells (NPS 3 to NPS 48).
4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
5. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.
6. All buried ductile iron pipe shall be encased in polyethylene wrap.

2.3 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:
1. Pipe: ASTM D 3034, SDR 26, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

B. PVC Gravity Sewer Piping (NPS 18 to NPS 36):
1. Pipe and Fittings: ASTM F 679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

C. PVC Pressure Piping:
1. Pipe: AWWA C900, Class 200 PVC pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: AWWA C900, Class 200 PVC pipe with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.
4. Fusible PVCP shall be manufactured of PVC resin compounds Class 12454 A or B conforming to ASTM D 1784 in accordance with ASTM D 2241. PVCP shall have a pressure rating of 200 psi (14 DR). Joints shall be fused.

2.4 HDPE PIPE AND FITTINGS

A. High density polyethylene pipe conforming to ASTM D3350-02 and AWWA C906-90, material shall be comprised of PE 3408. Product shall be from one of the following manufacturers or an approved equal: Drisco Pipe, Performance Pipe, or Plexico.
   1. Pipe shall have a minimum wall thickness of DR-11 or less as directed by the Authority and a working pressure rating of 160 psi or more.
   2. Materials and workmanship shall be as required by AWWA M55, PE Pipe Design and Installation Manual and ASTM F714 Manufacturing requirements.
   3. HDPE pipe, appurtenances, and installation methods shall conform to the latest addition of AWWA C906.
   4. Pipe shall be furnished in ductile iron pipe sizes (DIPs).
   5. Pipe shall be handled and installed in accordance with manufacturer's recommendations.
   6. Pipe shall be furnished with continuous, permanent print line identifying pipe size, pressure rating, trade name, material classification, ASTM and NSF standards, pipe test category, plant location and shift, date of manufacture, operator and extruder numbers, and supplier of raw materials.
   7. Exterior wall shall be permanently color coded to provide service identification. Stripes along the entire length of the pipe, 120 degrees apart, shall be made by co-extrusion or impregnation. Stripes for sanitary force mains shall be green.
   8. No installations shall exceed ten feet (10') of cover unless approved by the Engineer or as directed by the plans and specifications.

B. Fittings and Couplings: Fittings and specials shall be of the same construction and design as the pipe. The manufacturer of the pipe shall be the same as the manufacturer of the fittings and other fabrications.

C. Joints: Joints shall be thermally butt-fused according to the recommendations of the manufacturer.

D. HDPE Restraint Methods:
   1. Restrained joints include butt fusions, electro-fusions, socket fusions, bolted flange connections, MJ Adapter connections or other restrained mechanical connections.
   2. Provide joint restraints on long string of butt-fused HDPE to bell and spigot or mechanical sleeve joint.
      a. Wall Anchor:
         1) Restrain the transition connection by butt fusing a wall anchor in the HDPE pipeline close to the connection and pouring a concrete anchor around it as shown in Details. Refer to the pipe manufacturer’s recommendations on anchor size and pull out loads.
      b. Mechanical Joint.
         1) Restrain the transition connection and several non-PE bell and spigot joints down line from the transition connection.
         2) Distance of pipe restraint needs to be identified on the drawings and noted in the HDPE to DIP Connection Detail. At minimum the Contractor shall provide pipe restraint per the requirements of a “Dead End” pipe as noted in the “Pipe Restraint Schedule” or 3 pipe lengths, whichever is greater.

E. HDPE to DIP and DIP Fittings:
   1. MJ (mechanical joint) Adapters are to be used to connect polyethylene pipe to mechanical joint fittings and appurtenances that meet AWWA C111/ANSI A21.11.

2. Slip the Gland Ring over the pipe end and then butt fuse the HDPE MJ Adapter to the end of the pipe using the PPI Generic Butt Fusion Joining Procedure TR-33. Install the Gasket over the MJ Adapter and align the fitting with the socket hub of the ductile iron fitting. Lubricate the gasket, the end of the MJ adapter, and the inside of the socket hub with an approved pipe lubricant meeting AWWA C111. Do not use soapy water.
3. Insert the MJ Adapter into the socket hub. Make sure it is evenly and completely seated in the socket hub. The MJ Adapter and the socket hub must be aligned straight into each other. Insert the gland bolts, and run the nuts up finger-tight. Tighten the gland bolts evenly to the fitting manufacturer's recommended procedures.
4. When connecting to a valve with an MJ connection, longer T-bolts may be required. If the T-bolts that come with the kit are not long enough for the assembly, use a coupling nut and Grade 5 all thread to make up the length required.

F. HDPE Flanged Connection to DI Fittings:
1. Flanged joints can be used to attach HDPE pipe to valves or DI fittings using HDPE Flange Adapter, Back-Up Ring, Gaskets and Bolts, Nuts and Washers.
2. Connection is made by sliding the Back-Up Ring over the pipe end and then butt fusing the HDPE Flange Adapter to the end of the pipe using the PPI Generic Butt Fusion Joining Procedure TR-33. Align the flanges and back-up rings and follow the fitting manufacturer's recommended procedures for bolting the flanges together. The service pressure rating for the back-up ring should meet or exceed the service pressure in the pipe.
3. Gaskets are required for connections between polyethylene and non-polyethylene flanges. The gasket manufacturer should recommend the gasket to use with polyethylene pipe. This is considered a "fully restrained joint" and typically does not need external restraint devices.

G. Solid DI Sleeve Connections to HDPE pipe:
1. Solid Sleeves are ductile iron fittings designed to connect DI / PVC pipe to other piping materials including HDPE pipe. The solid sleeve is to have a flange or MJ hub to attach to the HDPE pipe. On the ductile iron pipe side, a Megalug flange is attached to the pipe and a gasket is installed over the pipe and into the sleeve before bolting the Megalug to the Sleeve flange. A standard HDPE MJ Adapter kit is used on the HDPE pipe side to complete the assembly.
2. Contractor is to follow manufacturer's recommended procedures for this assembly.

H. HDPE Pipe Connection to DI or PVC Bell End:
1. Flex restraint pieces are electro-fused to the HDPE pipe to achieve the proper stab depth in the PVC or DI bell and the restraint harness plate is attached behind them. The opposite end of the restraint harness is attached behind the DI /PVC hub.
2. Install the HDPE pipe in the PVC/DI bell until it bottoms out on the flex restraints and tighten the tie rods to prevent the assembly from pulling apart.
3. A stiffener is to be installed in the HDPE pipe end.
4. Contractor is to follow manufacturer's recommended procedures for this assembly.

I. Mechanical Connection – HPDE to PVC:
1. Provide coupling on plain-end PVC pipe to plain-end HDPE pipe without special adapters.
2. When connecting HDPE pipe to a mechanical coupling, the fitting unless otherwise stated by the coupling manufacturer.

2.5 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end. Couplings shall be Logan LCP Coupling, or Fernco Series 1001-66 or approved equal.

B. Sleeve Materials:
   1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Ring-Type, Flexible Couplings:
   1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.6 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:
   1. Joints for Ductile Iron Pipe to be Tyton, Bell Tite, Fast Tite or equal.
   2. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.

B. Cleanouts
   1. PVC Cleanouts:
      a. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.
      b. Cleanout to be constructed as noted in the Genoa - Oceola Sanitary Sewer Standard Details.
      c. PVC to meet ASTM D-3034.
      d. Cleanout lid to be heavy duty, EJIW 1574 Solid Cover or equal. Lid to be cast within concrete pad.

2.7 MANHOLES

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Diameter: 48 inches minimum unless otherwise indicated.
   3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
   4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
   5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
   6. Top Section: Eccentric-cone.
   7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.

8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection. Resilient Pipe Connector to be Kor-N-Seal or approved equal.
9. Steps: Individual steel-reinforced plastic steps; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step, minimum 10-inches wide. Cast or anchor steps into sidewalls at 16-inch intervals.
10. Grade Rings: Reinforced-concrete rings, 3- to 8-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
11. Provide interior manhole coating where manhole used for force main discharge. Coating shall be SpectraShield or approved equal.
12. All manholes shall be wrapped with Wrapid Seal joint wrap or equal.

B. Manhole Frames and Covers:
1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch minimum-width flange and 26-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.
3. Frame and Cover manufacturer make and model required for the Authority is noted in the Standard Details.

C. Manhole Adjustment
1. Precast concrete grade rings, 2" to 6" thick may be installed above the manhole cone to provide the adjustment of 3" to 8" according to standard details.
2. Where manholes require more adjustment than 8", the existing cone section of the manhole is to be removed and precast sections installed.
3. Adjusted manholes shall be grouted on the interior and exterior of the adjustment rings.

2.8 PLUG VALVES

A. Plug Valves:
1. Description: Resilient-seated 100% Port Eccentric.
   a. Standard: MSS SP-108, with 100% port opening.
   b. Body: Cast iron.
   c. Pressure Rating: 175-psig minimum CWP.
   d. Seat Material: Suitable for raw sewage service.
2. Plug Valves shall be Clow, Dezurik, Homestead, or Pratt, or GO SWATH approved equal.

2.9 RELIEF VALVES

A. Combination Air Valves:
1. Description: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.
   a. Standard: AWWA C512.
   b. Pressure Rating: 300 psig.
   c. Body Material: Cast iron.
   d. Trim Material: Stainless steel.
   e. Inlet and Outlet Size: Per Drawings Specifications
   f. Orifice Size: Per Drawings Specifications

g. Design Air Capacity: Per Drawings Specifications

2. Combination Air Valves shall be APCO, ARI model D-025 2" threaded inlet match detail, Crispin, or GO SWATH approved equal.

2.10 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:
   1. Cement: ASTM C 150, Type II.
   2. Fine Aggregate: ASTM C 33, sand.
   3. Coarse Aggregate: ASTM C 33, crushed gravel.
   4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi (minimum, with 0.45 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      a. Invert Slope: 1 percent through manhole.
   2. Benches: Concrete, sloped to drain into channel.
      a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
   1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
   2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.11 UTILITY MARKERS

A. All sanitary sewer leads shall have an electronic marker system furnished and installed complete with marker locator.
   1. Markers shall be installed in a horizontal position 3 to 4 feet below the ground surface at the end of the lead or at the property line.
   2. Utility markers to be Rhino FiberCurve and colored green for sanitary sewer systems.

B. Tracer wire is to be installed on all non-ferrous/metallic service lines and sanitary sewer pumping mains.
   1. For directional bores tracer wire shall be:
      a. Directionally Drilled tracer wire to be Copperhead ‘Soloshot’ Extra High Strength Directional Drill Wire 1150# Break Load or equal.
   2. For conventional open cut construction tracer wire shall be:
      a. Direct bury tracer wire to be Copperhead 10 CCS High Strength 600# Break Load or equal.
   3. Tracer wire shall be installed in a continuous fashion. Install trace wire on top of pressure process piping and secure to main every five (5) feet with tape.

4. The wire shall be brought to the surface at bore pits, valves, fittings or manholes through utility markers or tracer wire terminal boxes which may serve as access points. Trace wire shall be brought to the surface at least every five hundred (500) feet unless noted by the Owner. Care should be taken not to damage the wire coating. If wire coating is damaged, the Contractor shall repair the damaged coating with electrical tape.
5. Tracer wire shall terminate in boxes when at paved surfaces. Copperhead brand boxes shall be used. Model RB14*TP shall be used in asphalt installations and model CD14*TP shall be used for all other installations.
6. Tracer wire systems in rural areas shall terminate in Rhino Triview Tracing wire stations. Terminals shall be external and colored green for sanitary sewer systems. Terminals should be located at least every one thousand (1,000) feet, or as shown on the drawings.
7. Contractor shall test the locator system for continuity upon completed installation. Should tracer wires fail to test for continuity then the test shall be considered a failure.
8. Failure of the tracer wire shall result in the installation of utility markers at no additional cost to Owner.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 31 20 00 Earth Moving.

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling. Casing pipes may be required for certain crossings and to maintain accurate line and grade. Horizontal directional drilling is allowable for pressure mains.

F. Install gravity-flow, nonpressure, drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.

2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
3. Install piping with 66 inch minimum cover.
4. Install ductile-iron, gravity sewer piping according to ASTM A 746.
5. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
6. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
7. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.

G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:
1. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
2. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
3. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
4. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
5. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
a. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.4 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

E. Pipe to manhole connections shall be provided by the manufacturer or cored in the field. In no instance shall new holes be sledgehammered out.

3.5 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC pipe fittings in sewer pipes at branches for cleanouts, and use PVC pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block as shown in the Genoa – Oceola Sanitary Sewer Standard Details.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

A. Make connections to existing piping and underground manholes.
   1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
   2. Make branch connections from side into existing piping, NPS 4 to NPS 16.
      a. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
      b. Core existing pipe and install a tapping saddle such as the Romac "CB" Sewer Saddle or approved equal.
   3. Make branch connections from side into existing piping, NPS 18 or larger, using an Inserta-Tee of approved equal.
   4. Connections to existing sanitary sewer manholes will only be allowed through coring the structure and installing a flexible connector such as Kor-n-Seal or approved equal.
   5. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Fill abandoned pipe with grout. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
   1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads, grouted in place.
   2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
   1. Remove manhole and close open ends of remaining piping.
   2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Section 31 20 00 Earth Moving.

3.9 FIELD QUALITY CONTROL

A. Conduct acceptance tests for tightness on nonpressure sanitary sewers and laterals. In areas where live leads have to be connected as the Work progresses, then only a television inspection will be required. Do not enclose, cover, or put into service before acceptance tests have been passed unless approved by the Engineer.

Test sewers NPS 24 and smaller using low pressure air. Also test sewers for infiltration where groundwater is above the sewer invert. In areas where groundwater is more than 5 feet above the sewer invert, air test with dewatering system in operation or use infiltration test when dewatering is turned off and has returned to normal level. Make provisions for determining groundwater levels prior to testing.

Test sewers NPS greater than 24 using infiltration or exfiltration tests, as directed by the Engineer.

1. Schedule tests and inspections with the Authority with at least 24 hours' advance notice.
2. Submit a separate report for each test performed.
3. Defects requiring correction include the following:
    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.
4. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
5. Reinspect and repeat procedure until results are satisfactory.
6. Leaks and loss in test pressure constitute defects that must be repaired.
7. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

B. Low Pressure Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
1. Option: Test plastic gravity sewer piping according to ASTM F 1417.
2. Option: Test concrete gravity sewer piping according to ASTM C 924.
3. Testing procedure:
    a. Add air to line until internal pressure of 4 psig is obtained, allow for stabilization. Once 4.0 psig is held, allow the pressure to decrease to 3.5 psig, at which time, begin a stopwatch to determine the total time required for internal pressure to drop to 2.5 psig.
    b. Adjust pressure by adding 0.433 psi pressure for each foot of groundwater above the invert of the pipe being tested.
    c. Do not allow persons to be in the manhole during air testing.
    d. Do not allow internal pipe pressure to rise above 5.0 psi.
    e. Determine rate of air loss—check time for pipe to drop 1.0 psi and compare to allowable time listed in Low Pressure Air Test Tables included in this specification.

LOW PRESSURE AIR TEST TABLES
TIME REQUIRED FOR 1.0 PSIG PRESSURE DROP
WHEN TESTING ONE PIPE DIAMETER ONLY FOR SIZE AND LENGTH OF PIPE INDICATED.

TABLE FOR PVC, PVCP, ABS AND DI PIPE

1 Pipe Diameter (in.)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft.)	4 Time for Longer Length (sec.)	Test Time for Length (L) Shown (min:sec)							
				100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
4	3:46	597	0.380 L	3:46	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	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

TABLE FOR VCP AND CONCRETE PIPE

1 Pipe Diameter (in.)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft.)	4 Time for Longer Length	Test Time for Length (L) Shown (min:sec)							
				100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft
4	1:53	597	0.190L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	0.427L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	0.760L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709L	5:40	5:40	5:42	7:08	8:33	9:48	11:24	12:50
15	7:05	159	2.671L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
36	17:00	66	15.384L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23
42	19:50	57	20.939L	34:54	52:21	69:48	87:15	104:42	122:09	139:36	157:03

Note: When testing two sizes of pipe simultaneously, time shall be computed by ratio of lengths involved.
Example: 400 feet of 8-inch PVC pipe and 150 feet of 6-inch VCP pipe.

$$\text{Time} = \frac{\text{Length1} \times \text{Time1} + \text{Length2} \times \text{Time2}}{\text{Length1} + \text{Length2}}$$

$$\text{Time} = \frac{400 \times 10{:}08 + 150 \times 2{:}50}{400 + 150} = \frac{400 \times 608 + 150 \times 170}{400 + 150} = 489 \text{ seconds} = 8{:}09 \text{ (min:sec)}.$$

C. Hydrostatic Test (Gravity Sewer except HDPE): Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

1. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
2. Close openings in system and fill with water.
3. Purge air and refill with water.
4. Disconnect water supply.
5. Test and inspect joints for leaks.

D. Hydrostatic Testing (Pressure Pipe except HDPE): The section of pipe to be tested shall be filled with water, the entrained air within the line shall be removed, and water shall be pressurized up to test pressure at the pipe low point within 5 to 10 minutes.
   1. The test period shall start immediately after initial pressurization. The line shall be maintained under the test pressure for a continuous 2-hour period.
   2. The section of pipe to be tested shall hold the test pressure with no more than a 5 percent loss in pressure over the test period or the leakage per hour under the conditions of test shall not exceed values determined by the following equation:

$$L = \frac{SD\sqrt{P}}{148{,}000}$$

Where L = allowable leakage per hour (gallons)
S = length of pipe in test (feet)
D = nominal diameter of pipe (inches)
P = average test pressure (psi, gauge)

   3. Piping with flanged, grooved coupling, screwed, socket type, and welded joints shall be completely tight at the designated test pressure.
   4. The test pressure shall not vary by more than 5 psi throughout the entire test period.
   5. Test Pressures: Pipelines shall be tested at 1-1/2 times their working pressure.

E. Hydrostatic Test (HDPE Pipe): The section of pipe to be tested shall be filled with water, the entrained air within the line shall be removed, and water shall be pressurized up to test pressure at the pipe low point within 5 to 10 minutes. To compensate for expansion after initial pressurization, sufficient make-up water shall be added into the pipe system at hourly intervals for 3 hours to raise the pressure back up to the test pressure.
   1. After completion of this initial phase, approximately 4 hours after start of the testing procedure, the actual test shall begin.
   2. The system shall be pressurized up to the test pressure and by make-up water held continuously at the test pressure for at least 1 hour, but no more than 3 hours.
   3. The make-up water used during the test shall be measured and shall not exceed the allowance given in the following table.

ALLOWANCE FOR EXPANSION OF HDPE PIPE UNDER TEST PRESSURE

Allowance for Expansion
(U.S. Gallons per 100 Feet of Pipe)

Nominal Pipe Size (In.)	1-Hour Test	2-Hour Test	3-Hour Test
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.0	1.5
10	0.75	1.3	2.1
11	1.0	2.0	3.0
12	1.1	2.3	3.4
14	1.4	2.8	4.2
16	1.7	3.3	5.0
18	2.2	4.3	6.5
20	2.8	5.5	8.0
22	3.5	7.0	10.5
24	4.5	11.1	16.8
28	5.5	11.1	16.8
32	7.0	14.3	21.5
36	9.0	18.0	27.0
40	11.0	22.0	33.0
48	15.0	27.0	43.0
54	22.0	35.0	55.0

4. If there are no visible leaks or pressure drops greater than 5 psi during the actual test period, the system passes the test. If leakage is revealed, however, the defect shall be corrected and a retest shall be made after a 24-hour minimum depressurized recuperation period.

F. Ring deflection testing: A minimum of 30 days after the sewer has been installed, ring deflection testing shall be performed on all flexible pipe. Any pipe with deflection of 5 percent or greater will require replacement at no cost to the Owner.

G. Television inspection: Furnish materials, labor, and equipment for television inspection of all new sanitary sewers. Included will be necessary cleaning and pumping of sewage. Television inspection shall not take place until a maximum of 30 days after installation.
   1. Engineer's representative shall directly supervise televising and view recordings.
   2. Record sewer interior on video DVD which shall be turned over to Owner. Make recording on continuous running audio video DVD.
   3. The inspection shall involve visual observation by closed circuit television. Perform inspection at rate of speed which will allow examination of all points of infiltration, cracked or crushed pipe, defective joints, misalignment in line or grade, location of wye openings and other defects. Precisely locate and describe by detailed statement of condition any item which in opinion of Engineer requires repair.

4. As part of television inspection, note precise location of each wye in relation to downstream manhole. Record this location on wye location sheets supplied by CONTRACTOR.
5. If camera encounters dip in sewer such that water is standing above springline of sewer pipe, and if camera lens becomes submerged because of this condition, withdraw camera rig from sewer and insert from other end as far as possible. Prevent back flooding into reach from adjacent section.
6. Provide two copies of notes, wye locations and other pertinent information as part of television inspection report. Turn over one set of this information to ENGINEER upon completion of inspection of each line. Hold second copy of information until completion of Project, at which time assemble and turn it over to ENGINEER

H. Manholes: Perform hydraulic test according to ASTM C 969 or low-pressure vacuum air testing in accordance with ASTM C 1244-05ae1, and below.
1. All pipes must be connected to the manhole prior to testing, and the manhole must be backfilled and compacted above all joints and connections to be tested.
2. The trench shall be maintained in a dewatered condition such that no standing water is above any joint to be tested. Contractor shall provide a method for measuring the groundwater elevation adjacent to the manhole to be inspected.
3. Permanently plug all lift holes prior to air testing. All piping must be temporarily plugged, with the plug placed inside the pipe so that the connection between the boot and the manhole is tested.
4. A vacuum of 10 inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 inches of mercury.
5. The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the time as indicated in Table 1. Time shall be measured using a digital or analog stopwatch.
6. If the manhole fails the air test, the Contractor shall make all repairs by methods approved by the Engineer. The manhole shall then be retested until a satisfactory test is obtained.
7. The Engineer may require the reconstruction of any manhole that does not pass acceptance test at no additional cost to the Owner.

TABLE 1
SANITARY MANHOLE AIR TEST TABLE
MINIMUM TIME REQUIRED FOR 1.0 IN MERCURY PRESSURE DROP

	Diameter, in								
Depth, ft	30	33	36	42	48	54	60	66	72
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	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	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	98	108	121

1. Time given is in seconds
2. The depth of the manhole is measured from the top of the manhole cover to the floor of the manhole. If the depth of the manhole is not listed, the next higher value shall be used.
3. The largest diameter section of the manhole shall be used to determine time required.

3.10 CLEANING

A. Clean dirt and superfluous material from interior of piping.

END OF SECTION 22 13 13