02530 – SANITARY SEWER

(Last revised (6/22/10)

SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this specification.

B. Section 02275 – TRENCHING, BACKFILLING AND COMPACTION OF UTILITIES.

C. American Concrete Institute (ACI) 308, *Guide to Curing Concrete*

D. American Concrete Institute (ACI) 318, *Building Code Requirements for Structural Concrete*

E. AWWA C600: *Standard for Installation of Ductile-Iron Water Mains and their Appurtenances*

F. AWWA C900: *Pressure Pipe and Fabricated Fittings (4" through 12") for Water Distribution*

G. National Electrical Code (NEC)

H. National Electrical Manufacturers Association (NEMA)

I. North Carolina State Building Code: *Building Code*, Section 1609 *Wind Loads*

J. North Carolina State Building Code: *Plumbing Code*

K. Standard Rules of American Institute of Electrical Engineers

L. Uni-Bell Handbook, Latest Edition

M. UNI-B-6: *Recommended Practice for Low-Pressure-Air Testing of Installed Sewer Pipe*

N. UNI-B-9: *Recommended Performance Specification for Polyvinyl Chloride (PVC) Profile Wall Gravity Sewer pipe and Fittings Based on Controlled Inside Diameter (Nominal Pipe Sizes 4-48 inches)*

O. UNI-PUB-6: *Recommended Installation Guide for PVC Solid-Wall Sewer Pipe (4-15 inch)*

P. UNI-PUB-9: *Installation Guide for PVC Pressure Pipe*

1.2 SUMMARY

A. This section includes sanitary sewer piping and specialties for municipal sewer and services outside of building structures.

1.3 DEFINITIONS

A. **GENERAL**:

For the purposes of this specification, the following definitions refer to sanitary sewer collection and pressure systems that come under the authority of Town of Clayton as specified within this section and other sections of this manual.

1) **Cleanouts**: A riser pipe off of a service line that provides access to the line for the purpose of line cleaning.

2) **Easement**: An instrument that depicts/describes and conveys rights and privileges to the Town for the placement, access to and maintenance of a utility line across and/or on the property of a second party. Ownership of the land remains with the second party.

3) **Sanitary Sewer**: Exterior gravity or pressure public sanitary sewer systems.

4) **Force Main:** Pressure sanitary sewer systems.

5) **Lift/Pump Station:** A combination wetwell/pump station and appurtenances.

6) **Sewer Service**: Exterior domestic sewer piping which connects to the public sewer system.

B. The following are industry abbreviation for various pipe materials:

1) **AC**: Asbestos Cement Pipe
2) **CI**: Cast Iron Pipe
3) **DIP**: Ductile Iron Pipe
4) **RCP**: Reinforced Concrete Pipe
5) **PVC**: Polyvinyl Chloride Pipe

1.4 PERFORMANCE

A. Gravity Flow, Nonpressure Piping Pressure Ratings: At least equal to the system test pressure.

B. Force Main Pressure Ratings: At least equal to the system operating pressure plus 50 psi, but no less than 150 psi.

1.5 SUBMITTALS

A. Submit product data for the following. For third party projects, the Developer/Project Engineer shall perform all product review/certification and make a submittal at the end of the project to the Town. The engineer shall be duly licensed in North Carolina.

1) Piping Specialties.
2) Air & vacuum release valves and accessories.
3) Autodialers.
4) Sewage Pumps and appurtenances, operating manuals.
5) Auxiliary Generators.
6) Alarm Devices.
7) Precast Concrete Manhole Castings.
8) Piping Paint.

B. Submit shop drawings for the following:

1) Precast Concrete Vaults and wetwells, including frames and covers, ladders, drains, access hatches, wall sleeves, valve support stands, pumps, and motors.

C. **Coordination Drawings**: Show manholes and other structures in vicinity, pipe sizes and elevations, elevations of lift station elements such as influent lines, floats, etc.

D. **Computations**:

1) Buoyancy calculations for wetwells, manholes, interceptor/outfalls, and mains with shallow cover.

2) Provide structural calculations for any elevated main and pier system where span of the main exceeds the joint length. Provide calculations for all aerial mains, and their supporting structures that are subject to hydrodynamic forces.

E. **Bypass Pumping**: Bypass pumping operations must be approved by the Town before starting. Provide a detailed written plan of how the bypass pumping operation shall be performed two weeks prior to the operation. See Section 3.6 of this specification.

F. **Project Closeout**: Submit 3 copies of manufacturer's maintenance and operation manuals on all sewage pumps and/or package lift stations and appurtenant devices.

1.6 QUALITY ASSURANCE

A. Materials and operations shall comply with the latest revision of the Codes and Standards listed in Section 1.7, below.

B. Piping materials shall be marked clearly and legibly.

1) Ductile Iron Pipe shall show on or near bell:

a. Weight,
b. Class or nominal thickness,
c. The letters “DI” or “Ductile,”
d. Manufacturer’s identifying mark,
e. Year in which pipe was made, and
f. Casting period.

2) PVC pipe shall show identification marks, at intervals not to exceed 5 feet, as follows:

a. Nominal pipe diameter,
b. PVC cell classifications,
c. Company, plant, shift, ASTM, SDR and date designation,
d. Service designation or legend.
e. All PVC pipe shall bear the National Sanitation Foundation seal of approval.

3) Steel pipe shall be marked as follows. Each length of pipe and each special section shall be legibly marked by paint stenciling, die stamping or hot-roll marking to show the following:

a. Manufacturer’s name or mark,
b. Size and weight of the pipe or special section,
c. The type of steel from which the pipe or special section was made.

C. *“Gravity Sanitary Sewer Design and Construction*,” ASCE Manuals and Reports on Engineering Practice – NO. 60, WPCF Manual of Practice NO. FD-5.

D. AWWA C600: Installation of Ductile Iron Water Mains and Appurtenances.

E. NC Department of Environment and Natural Resources, Division of Water Quality, NCAC Title 15A 2T .0200 *Waste not Discharged to Surface Waters*, latest revision.

1.7 QUALITY STANDARDS

A. Materials and operations shall comply with the latest revision of the Codes and Standards listed below:

AASHTO American Association of State Highway Transportation Officials.

ACI American Concrete Institute

ACPA American Concrete Pipe Association

ANSI American National Standards Institute

AREA American Railway Engineers Association

ASCE	American Society of Civil Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
CRSI	Concrete Reinforcing Steel Institute
FS	Federal Specifications
MSDS	Material Safety Data Sheets
NCDENR	North Carolina Department of Environment and Natural Resources
NCDOT	North Carolina Department of Transportation
NCMA	National Concrete Masonry Association
NCPI	National Clay Pipe Institute
NSF	National Sanitation Federation International
OSHA	Occupational Safety and Health Administration
UL	Underwriters Laboratories, Inc.
WEF	Water Environment Federation

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

Materials used for the construction of gravity sewer, pressure mains and appurtenances in the Town's sewer collection system shall be new, free of defects, and meet the highest standards set forth. The Town's authorized representative must inspect, review, and approve all materials to be used for sewer main and appurtenances prior to installation. At the option of the Town, any material installed without inspection will have to be sufficiently removed for inspection and review. Any additions, deletions, or changes from the Town's approved plan set must be submitted to the Town for approval, prior to making changes in the field.

A. **PIPE CONDITION/PIPE EXAMINATION:**

1) **New Pipe Inspection**: Inspect materials thoroughly, including the interior, upon arrival. Examine materials for damage and to ensure that the right pipe has been delivered to the site. Remove damaged or rejected materials from site. Pipe shall be protected during handling against impact shocks and free fall. Pipe shall be kept clean at all times,

and no pipe shall be used in the work that does not conform to the appropriate ASTM Specifications.

2) **Pre-Installation Inspection**: Prior to being installed, each section of the pipe shall be carefully examined for damage and conformity with these specifications. All pipe damaged or deemed not to conform to these specifications shall be rejected and removed from site. All pipe in which the spigots and bells cannot be made to fit properly, or pipe, which has chipped bells or spigots, will be rejected. The faces of all spigots ends and of all shoulders on the bells must be true. Examine bell and spigot for uniformity and smoothness of liner and barrel.

B. Protect pipe coating during handling using methods recommended by the manufacturer. Use of bare cables, chains, hooks, metal bars, or narrow skids in contact with coated pipe is not permitted.

C. Prevent damage to pipe during transit. Repair abrasions, scars, and blemishes to the satisfaction of the Town. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.

D. Observe manufacturer's directions for delivery and storage of materials and accessories.

E. Protect stored piping from entry of water or dirt into pipe. Protect bells and flanges of special fittings from entry of moisture and dirt.

F. Support pipe to prevent sagging or bending. Do not store plastic pipe, structures, and fittings in direct sunlight for more than one week.

G. Handle precast concrete manholes and other structures according to manufacturer’s written rigging instructions.

H. Construct piping to accurate lines and grades and support as shown in drawings or prescribed in specifications. When temporary supports are used, ensure that sufficient rigidity is provided to prevent shifting or distortion of pipe.

1.9 PRODUCT SUBSTITUTIONS

The Town will approve materials not specified but deemed equal, on a case-by-case basis. If submitting new products, submit in writing with documentation and samples of materials to the Town of Clayton. New materials approved for the sewer collection system will be incorporated into these specifications after approval by the Town.

1.10 PROJECT CONDITIONS

1.10.1 SEPARATION OF WATER AND SANITARY AND/OR COMBINED SEWERS

A. Follow the NCDENR standards for separation of water mains and sanitary sewers lines.

B. **PARALLEL INSTALLATIONS:**

1) **Preferred/Normal Conditions** – Sewer mains or sewer manholes shall be constructed at least 10 feet horizontally from water lines whenever possible. The distance shall be measured edge-to-edge.

2) **Unusual Conditions** – When local conditions or barriers prevent a horizontal separation of at least 10 feet, the sewer main or sanitary sewer manhole may be laid closer to a water line provided that:

   a. The sewer line shall be placed in a separate trench, with elevation of the top of the sewer line at least 18 inches below the bottom of the water line; or

   b. The sewer line shall be placed in the same trench as the water, and located to one side, on a bench of undisturbed earth, and the elevation of the top of the sewer line at least 18 inches below the bottom of the water main; or

   c. If it is impossible to obtain proper horizontal and vertical separation as described above or anytime the sewer is above the water main, both the water main and sewer must be constructed of DIP complying with public water supply design standards and must be pressure tested to 150-psi to assure watertightness before backfilling. The sewer manhole shall be of watertight construction and tested in place.

C. **SEWER MAINS CROSSING BELOW WATER MAINS:**

1) **Preferred/Normal Condition** – sewer lines shall be constructed to cross below water lines whenever possible and shall be laid to provide a vertical separation of at least 18 inches between the bottom elevation of the water line and the top of the sewer.

2) **Unusual Conditions** – when local conditions or barriers prevent an 18 inch vertical separation as described in *Preferred/Normal Conditions* (paragraph immediately above), one of the following construction methods shall be used:

   a. Both the water main and sewer shall be constructed of ferrous materials and with joints that are equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. Both the water main and sewer shall be pressure tested at 150-psi to assure watertightness before backfilling.

   or

   b. Either the water main or the sewer main may be encased in a watertight encasement pipe which extends 10 feet on both sides of the crossing, measured perpendicular to the water main. The encasement pipe shall be of materials approved by NCDENR for use in water main construction (e.g. DIP, steel). If the sewer main is encased, the DIP sewer carrier pipe shall be DIP continuous from manhole to manhole. If the water main carrier pipe is encased, the water shall be constructed of either DIP or PVC meeting these specifications.

D. **SEWER MAINS CROSSING ABOVE WATER MAINS:**

1) **Unusual Conditions** – when local conditions prevent an 18 inch vertical separation, as described in paragraph C, *Sewer Mains Crossing Below Water Mains*, *Preferred/Normal Condition*, above, the following construction shall apply:

   a. Whenever it is necessary for a water main to cross under a sewer, both the water main and the sewer shall be constructed of ferrous materials and with joints equivalent to water main standards for a distance of 10 feet on each side of the point of crossing. A section of water main pipe shall be centered at the point of crossing. Both the water main and sewer shall be pressure tested at 150-psi to assure watertightness before backfilling. The sewer line shall be ductile iron from manhole to manhole.

   b. Provide adequate structural support for the sewers to prevent excessive deflection of the joints, which can result in settling on and/or breaking the water line.

E. **SEWER MAINS AND OTHER UTILITIES:**

1) **Horizontal Separation – Preferred/Normal Condition** – Sewer lines shall be constructed to provide at least 10 feet from water mains and 3 feet of horizontal separation from other utilities whenever possible. The distance shall be measured edge-to-edge.

2) **Vertical Separation – Preferred/Normal Condition** – Whenever it is necessary for another utility to cross a sewer main, a 12-inch vertical separation shall be maintained between the lines (see paragraph H, *Storm Drainage System*) for vertical clearances between sanitary sewers and storm sewers. When local conditions prevent a 12-inch vertical separation, the following construction shall apply:

   a. Provide adequate structural support for the utility to prevent excessive deflection of the joints, which can result in settling on and/or breaking the sewer line.

   b. The sewer line shall be constructed of AWWA approved Ductile Iron Pipe with material transition a minimum of 20 feet upstream from the intersection and shall continue to the next manhole.

F. **Sanitary Sewer Manholes**: No water main shall be allowed to pass through or come in contact with any part of a sewer manhole. A minimum of 3 feet of horizontal separation shall be maintained between water mains and sanitary sewer manholes provided that the applicable provisions of paragraph B, *Parallel Installations, Unusual Conditions*, above, are also met.

G. **SANITARY SEWER AND WATER SERVICES**: DWQ permits the collection system, not the taps into the sewer main except in the case of private permits. The Minimum Design Criteria for Gravity Sewers does not mention taps nor are they shown on the as-built drawing plan and profiles. As such, 15 NCAC 02T rules define a sewer service as follows:

> *Building Sewer* means that part of the drainage system that extends from the end of the building drain and conveys the discharge from a single building to a public gravity sewer, private gravity sewer, individual sewage disposal system or other point of disposal.

The NC State Plumbing Code has an identical definition. Consequently, the separation requirements for water and sewer services fall under the requirements the *NC State Building Code: Plumbing Code (IPC with North Carolina Amendments),* Section 603.2 *Separation of Water Service and Building Sewer*, latest revision. Those provisions are generally as follows:

a. Water service pipe and the building sewer shall be separated by 5 feet of undisturbed or compacted earth. However, in accordance with *Water & Sewer Design*, paragraph 1.2.1.R *Water Distribution*, the horizontal separation between a water and sewer service within a public right of way or utility easement shall be no less than 3 feet. See **Standard Detail C07.03**).

b. A minimum 12-inch vertical separation with bottom of water above top of sewer and pipe material meets the provisions of this specification.

c. Water can be located in same trench with sewer if pipe material meets the provisions of this specification.

d. Separation is not required if water is sleeved to a point 5 feet either side of the sewer centerline with pipe material meeting Table 605.3, Table 702.2 or Table 702.3 of the NC State Building Code: Plumbing Code, latest revision.

H. **Storm Drainage System**: Sewers shall be located a minimum of 5 feet from storm interceptor drains and 10 feet from surface drainage ditches or a stream, lake or impoundment. No gravity sewer or sewer lateral shall pass through a storm drain pipe or manhole system.

I. **New Utilities and Existing Sewer Mains**: When installing a new utility adjacent to or in close proximity to an *existing* sewer main, the new utility line shall be installed to provide the minimum horizontal and vertical clearances specified in paragraph E, *Sewer Mains and other Utilities*.

J. **Protection of Wells** – A distance of 100 feet shall be maintained between any private well and a gravity sewer, force main or manhole structure. If this separation cannot be maintained, DIP with joints equivalent to public water supply design standards and pressure tested to 150-psi to assure weathertightness, shall be used. However, given the sewer meets these requirements, no gravity sewer, force main, or manhole structure shall pass or be placed within 25 ft of a private well or 50 feet of a public water supply well, source or structure.

1.11 SERVICE INTERRUPTION

A. Contact the Town to coordinate interruption of services. If interruption is necessary, the interruption shall be arranged to occur at such a time to cause the least disruption and minimize loss of service. At the direction of the Town

Engineer, temporary service may be required to be provided. Provide a minimum of 72 hours notice of the proposed utility interruption.

1.12 COORDINATION

A. Coordinate tie-in to municipal sewer mains and manholes with the Town Engineer. Connections to the Town's sewer systems (manholes, wetwells, force mains or any other part of the sewer system) must be witnessed by a representative of the Town; otherwise, the Town will not accept the new system.

B. Service is to be continuously maintained to customers in the project areas except for the minimum amount of time required to make connections with the existing system. At the direction of the Town Engineer, temporary pumping/bypass of sewerage flow may be required to be provided. See paragraph 3.6, *Bypass Pumping* for bypass pumping requirements and procedure.

C. When traffic signals, loops, or their appurtenances are likely to be damaged or interfere as a result of the construction, coordinate temporary operation with the applicable agency having jurisdiction of the signals. Provide a minimum of 1 weeks notice prior to anticipated disturbance or interruption. At the discretion of the Town Engineer, the notice may be required to be published in the newspaper.

D. Repair of pavement markings: When cuts are made through any paved surface and the cuts extend through the pavement markings, the replaced pavement shall be marked to match the existing.

E. Contact ***"NC One Call"*** at 811 before digging.

Know what's **below.** **Call** before you dig.

PART 2 – PRODUCTS

2.1 PIPE & FITTINGS

The following references provide the minimum standards as they apply to the specific item listed. In all cases, the latest revision shall apply.

2.1.1 DUCTILE IRON PIPE

Ductile iron pipe shall be Grade 60-42-10 and manufactured in accordance with all applicable requirements of AWWA C151/ANSI A21.51 and ASTM A746, Standard Specification for Ductile Iron Gravity Sewer Pipe for 4-inch and larger diameter pipe, thickness class rated, class 50 minimum. The thickness of Ductile Iron Pipe shall be determined by considering trench load in accordance with ANSI C150 and AWWA A21.50. (Public Sewers shall be no less than 8-inch diameter).

All pipe and fittings shall be lined with a minimum of 40 mils nominal dry film thickness of Protecto 401 Ceramic Epoxy when pipe is to be used for sewer only. Protecto 401 is an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Protecto 401 shall have a permeability rating of 0.00 when tested according to Method A of ASTM E-96, Procedure A with at test duration of 30 days.

SewperCoat Alternate: SewperCoat calcium aluminate mortar lining, as manufactured by Lafarge Calcium Aluminates (or approved equal), is an acceptable alternative to Epoxy (Protecto 401) when pipe is to be used for sewer only. SewperCoat is a calcium aluminate mortar made of fused calcium aluminate cement and fused calcium aluminate aggregates. The thickness of the lining shall be the thickness identified on AWWA C104, Sec. 4.7, paragraph 4.7.1, latest revision but no less than 0.125 inch for 6-inch through 12-inch and 0.1875 inch for 14-inch through 24-inch pipe. The lining thickness may taper to less than the specified at the ends of the pipe. Cracks, other than closed hairline cracks and/or fine crazing shall not be acceptable. Loose areas of cement lining are not allowable. A seal coat shall be applied to the lining as identified on AWWA C104, Sec. 4.11.

Outside coat shall be a minimum of 1 mil bituminous paint according to ANSI/AWWA C151/A21.21 Section 51-8.1.

Each joint of ductile iron pipe shall be hydrostatically tested before the outside coating and inside lining are applied at the point of manufacturer to 500 psi. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any rupture or leakage of the pipe wall.

All materials used in production of the pipe are to be tested in accordance with AWWA C151 for their adequacy within the design of the pipe, and certified test results are to be provided to the Town upon request. All certified tests, hydrostatic and material are to be performed by an independent testing laboratory at the expense of the pipe manufacturer.

Push-on and mechanical joint pipe shall be as manufactured by the American Cast Iron Pipe Company, Atlantic States Cast Iron Pipe Company, United States Pipe and Foundry Company, or Griffin Pipe Products Company.

A. **DUCTILE IRON JOINTS:**

Pipe joints may be either push-on or mechanical joint pipe sizes 4 inches through 48 inches in diameter. Rubber Gasket Joints and Mechanical Joints shall comply with AWWA C111/ANSI A21.11, ASTM A536 *Standard Specification for Ductile Iron Castings*. Acceptable pipe joints are as follows:

1) **Push-on Joint, Ductile Iron Pipe** shall conform to AWWA C151/ANSI A21.51 (such as *"Fastite," "Tyton,"* or *"Bell-Tite."*). The dimensions of the bell, socket, and plain end shall be in accordance with the manufacturer's standard design dimensions and tolerances. The gasket shall be of such size and shape to provide an adequate compressive force against the plain end and socket after assembly to affect a positive seal. Gaskets shall be vulcanized natural or vulcanized synthetic rubber, and comply with AWWAC111/ANSI A21.11.

2) **Mechanical Joint, Ductile Iron Pipe** shall be used only at the specific locations indicated on the drawings or as approved by the Town.

   a. The mechanical joint shall consist of:

i. A bell cast integrally with the pipe or fitting and provided with an exterior flange having cored or drilled bolt holes and interior annular recesses for the sealing gasket and the spigot of the pipe or fitting;

ii. A pipe or fitting spigot;

iii. A sealing gasket;

iv. Separate ductile iron follower gland having cored or drilled bolt holes; and

v. Ductile iron tee head bolts and hexagon nuts.

b. The joint shall be designed to permit normal expansion, contraction, and deflection of the pipe or fitting while maintaining a leak proof joint connection. The mechanical joint shall conform to the requirements AWWA C111/ANSI A21.11, and ASTM A536 Standard Specification of Ductile Iron Castings.

c. **Mechanical Joint Bolt Torque**: See Section 3.1.2, paragraph B, *Mechanical Joint Bolt Torque*, below.

B. **DUCTILE IRON FITTINGS:**

Fittings shall be ductile iron at least class 54 thickness and shall conform to AWWA C110/ANSI A21.10 or AWWA C153/ANSI 21.53 for compact fittings. All ductile iron fittings shall have a minimum working pressure rating of 250 psi and minimum iron strength of 25,000 psi. All fittings shall be high alumina cement mortar lined in accordance with ANSI/AWWA C-104/A21.4 and the outside shall be bituminous coated. The fittings shall be tested and the manufacturer shall provide certified test results when requested by the Town. This testing shall include hydrostatic proof testing of fittings. Acceptable types of fittings include Push-On Joint and Mechanical Joint.

1) **Mechanical Joint Restraint Systems -** Mechanical joint restraint systems shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWA C110/A21.10. Mechanical joint restraint systems (gland body, wedges and wedge actuating components) shall be constructed of grade 65-45-12 ductile iron material in accordance with ASTM 536. For applications requiring restraint 30 inches and greater, an alternate grade of iron meeting the material requirements of ASTM A536 is acceptable provided the device meets all the end product performance requirements. An identification number consisting of the year, day, plant and shift, shall be cast into each gland body. Sizes 3-inch through 16-inch shall be rated at 350-psi minimum working pressure and sizes 18 inches and larger rated at 250-psi minimum working pressure. Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes. Bolt heads are to be “auto-torque” twist off. Mechanical joint restraint systems shall accommodate all classes of ductile iron pipe (pressure class 350 through pressure class 150 and class 56 through 50) and appurtenances such as valves and hydrants without damage to the fitting, pipe or cement linings. Consult with manufacturer when use is

intended for grey iron pipe. All components shall be manufactured and assembled in the United States. Restraint shall be Megalug series 1100 mechanical joint restraint by EBAA Iron Sales, Inc., Ford wedge action restrainer gland UFR Series 1400, or approved equal.

C. **DUCTILE IRON SEWER SERVICES:**

Ductile iron pipe for sewer services shall be minimum thickness class 51 slip joint pipe with mechanical joint fittings. The service shall include the clean-out stack provided with a cast iron ferrule with brass clean-out plug. See **Standard Detail 533.01**.

2.1.2 PVC PIPE

A. **PVC SOLID WALL PIPE AND FITTINGS (GRAVITY PIPE)**

1) **PVC Solid Wall Gravity Pipe**: PVC Solid Wall Sewer Gravity Pipe and Fittings, Bell and Spigot Joints shall comply with ASTM D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings, SDR 35 minimum (4 inches - 15 inches). For 18 inch diameter PVC, comply with the requirements of ASTM F679, Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings, or latest revision, type PSM. Pipe shall be made of PVC plastic having a cell classification of 12454 B or 12454 C or 12364 C or 13364 B, with a minimum tensile modulus of 500,000 psi as defined in ASTM D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds, and shall be appropriately marked. Laying lengths shall be a minimum of 12.5 feet for pipes 15 inches or less and 11 feet for the pipes greater than 15 inches.

PVC pipe strength shall be capable of withstanding stiffness, flattening, and impact test as scheduled or referenced in ASTM D3034 or ASTM F949. Smooth wall pipe shall have a Standard Dimension Ratio (SDR) of 35 or less. All PVC pipe shall have a minimum pipe stiffness of 46 psi when measured at 5 percent vertical ring deflection and tested in accordance with ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe*.

With the exception of services, PVC Fittings shall not be used with pipes 4 inches and larger in diameter.

2) **PVC GRAVITY PIPE JOINTS:** Joints for Solid Wall PVC Sewer Gravity Pipe & Fittings and (Elastomeric flexible seals (Gaskets) shall be compatible with pipe and shall meet the requirements of ASTM D3212 *Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals*. Rubber Gaskets shall be used which conform to the requirements of ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe*.

B. **C900 PVC PIPE FOR GRAVITY SEWER AND SEWER FORCE MAINS (4-inch through 12-inch)**

1) C900 PVC gravity and pressure pipe, 4-inch through 12-inch, with bell end with gasket and spigot end shall comply with AWWA C900, Pressure Class 150, DR 18. Pipe shall also meet ASTM D2122, *Standard Method of Determining Dimensions of Thermoplastic Pipe and Fittings*, and ASTM D3139, *Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals*. Pipe shall have a bell with an integral wall section with a factory installed, solid cross section elastomeric ring in accordance with ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.*

2) The pipe shall be extruded from Class 12454-A or 12454-B PVC compound as defined in ASTM D-1784. Stress due to working pressure cannot exceed the HDB[1] (4000 psi) ÷ 2.5 safety factor (HDS = 1,600 psi). The pipe outside diameters shall conform to dimensions of Ductile Iron Pipe. All pipe furnished shall be in conformance with AWWA C900, latest revision.

3) The minimum pipe stiffness shall be 364 psi.

4) In accordance with ASTM D1599, *Standard Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings,* a minimum pipe burst of 755 psi shall be withstood without failure.

5) The pipe must be able to withstand an impact of 100 foot-pounds without visible evidence of shattering or splitting as specified in ASTM D2444, *Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight*).

6) Pipe shall be homogenous throughout. It shall be free from voids, cracks, inclusion, and other defects. It shall be as uniform as commercially practical in color, density, and other physical properties. Pipe surfaces shall be free from nicks and scratches. Joining surfaces of spigots and joints shall be free from gouges and imperfections that could cause leakage.

7) Each length of pipe furnished shall bear identification marking that will remain legible after normal handling, storage, and installation. Markings shall be applied in a manner that will not weaken or damage the pipe. Markings shall be applied at intervals of not more than 5 feet on the pipe. The minimum required markings are given in the list below. Marking requirements shall be in conformance with AWWA C900.

    a. Nominal Size and OD Base (e.g. 12CI)
    b. PVC
    c. Dimension Ratio (e.g. DR 18)
    d. AWWA pressure rating (e.g. PR 150)
    e. AWWA designation number (AWWA C900)
    f. Manufacturer's name or trademark
    g. Manufacturer's production code, including day, month, year, shift, plant, and extruder of manufacture.

[1] Hydrostatic Design Basis

8) C900 pressure pipe for force mains shall be used with ductile iron fittings (restrained joint).

C. **C905 PVC PIPE FOR GRAVITY SEWER MAINS (14-inch through 24-inch)**

1) AWWA C905 PVC gravity pipe, 14-inch through 24-inch, with bell end with gasket and spigot end, shall comply with AWWA C905, Minimum Pressure class 160, DR 18. Pipe shall also meet ASTM D2122, *Standard Method of Determining Dimensions of Thermoplastic Pipe and Fittings*, and ASTM D3139, *Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals*. Pipe shall have a bell with an integral wall section with a factory installed, solid cross section elastomeric ring in accordance with ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.*

2) The pipe shall be extruded from Class 12454-A or 12454-B PVC compound as defined in ASTM D-1784. Stress due to working pressure cannot exceed the HDB[2] (4000 psi) ÷ 2 safety factor (HDS = 2,000 psi). The pipe outside diameters shall conform to dimensions of Ductile Iron Pipe. All pipe furnished shall be in conformance with AWWA C905, latest revision.

3) Pipe shall be homogenous throughout. It shall be free from voids, cracks, inclusion, and other defects. It shall be as uniform as commercially practical in color, density, and other physical properties. Pipe surfaces shall be free from nicks and scratches. Joining surfaces of spigots and joints shall be free from gouges and imperfections that could cause leakage.

4) Each length of pipe furnished shall bear identification marking that will remain legible after normal handling, storage, and installation. Markings shall be applied in a manner that will not weaken or damage the pipe. Markings shall be applied at intervals of not more than 5 feet on the pipe. The minimum required markings are given in the list below. Marking requirements shall be in conformance with AWWA C905.

a. Nominal Size and OD Base (e.g. 14CI)
b. PVC
c. Dimension Ratio (e.g. DR 18)
d. AWWA pressure rating (e.g. PR 160)
e. AWWA designation number (AWWA C905)
f. Manufacturer's name or trademark
g. Manufacturer's production code, including day, month, year, shift, plant, and extruder of manufacture

D. **PVC PIPE FOR SMALL SEWER FORCE MAINS (2-inch)**

2-inch PVC pressure pipe, bell end with gasket and spigot end shall comply with ASTM D2241, *Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)*, SDR 21, Class 200 minimum. Materials shall meet

[2] Hydrostatic Design Basis

ASTM D1784, *Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds*.

Joints for Solid Wall PVC Sewer Gravity Pipe & Fittings and Elastomeric flexible seals (Gaskets) shall be compatible with pipe and shall meet the requirements of ASTM D3212 *Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals*. Rubber Gaskets shall be used which conform to the requirements of ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe*.

E. **DIRECTIONALY BORED HDPE PIPE FOR SEWER FORCE MAINS**

1) All polyethylene pipe, tubing, and fittings shall conform to all applicable provisions and requirements of the latest revision of AWWA C901, AWWA C906, or CSA B137.1 and, by inclusion, all appropriate standard references therein. Polyethylene compounds utilized in the manufacture of products furnished under this specification shall have a grade of PE24 with a minimum cell classification of PE 234363(C, D, or E) for PE2406-2606 materials, or a grade of PE34 with a minimum cell classification of PE 345464(C or E) for PE3408/PE3608 materials, as defined in ASTM D3350. In conformance with AWWA C901, AWWA C906, or CSA B137.1, they shall have a PPI recommended Hydrostatic Design Basis (HDB) of 1250 psi (PE2406/2606) or 1600 psi (PE3408/PE3608) at a temperature of 73.4°F (23°C).

   All materials which come in contact with water, including lubricants, shall be evaluated, tested, and certified for conformance with ANSI/NSF Standard 6.1.

   Clean re-work material of the same type grade, and cell classification generated from the manufacturer's own pipe and fitting production may be used by the same manufacturer as long as the pipe, tubing, and fittings produced meet the requirements of AWWA C901, AWWA C906, or CSA B137.1.

2) **Reference standards**

   AWWA C901: Polyethylene (PE) Pressure Pipe and Tubing, 1/2-inch through 3-inch for Water Service.

   AWWA C906: Polyethylene (PE) Pressure Pipe and Tubing, 4-inch through 63-inch for Water Service.

   ASTM D2657: Standard Practice for Heat Joining Polyolefin Pipe and Fittings.

   ASTM D2683: Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

   ASTM D2837: Standard Test Method for Obtaining Hydrostatic Design Basis of Thermoplastic Pipe Materials.

ASTM D3261: Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

ASTM D3350: Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.

ASTM F714: Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

ASTM F1055: Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.

PPI TR-3: Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.

PPI TR-4: Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fitting Compounds.

ANSI/NSF: Standard Number 61 for Drinking Water Systems Components – Health Effects.

NSF Standard #14: Plastic Piping Components and Related Materials.

CSA B137.1: Polyethylene Pipe, Tubing, and Fittings for Cold Water Pressure Services.

3) **Qualification of Manufactures**

The manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by these specifications. Given reasonable notice, the manufacturer's production facilities shall be open for inspection by Town or their representative. Qualified manufacturers shall be approved by the Project Engineer. Approved manufacturers include Plexco Performance Pipe Division-Chevron Chemical Company.

4) **Manufacturer's Quality Control**

The manufacturer of the Polyethylene pipe and fittings shall have an established quality control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rate, and contamination. The cell classification properties of the material shall be certified by the supplier. Incoming materials shall be approved by Quality Control before processing into finished goods. Outgoing products shall be tested as required in AWWA C901 or AWWA C906, as applicable.

5) **Pipe and Tubing**

Pipe and tubing furnished under this specification shall be manufactured using compounds complying with the requirements of paragraph A above. Dimensional performance characteristics shall conform to the requirements of AWWA C901, C906, or CSA B137.1. The pipe's DR

(Dimension Ratio) and Working Pressure (WPR) shall be as specified or shown on the drawings.

6) **Fittings**

Polyethylene fittings furnished under this specification shall be manufactured using compounds complying with the requirements of paragraph A above and all appropriate requirements of AWWA C901, C906, or CSA B137.1 Socket type fittings shall comply with ASTM D2683. Butt fusion fittings shall comply with ASTM D3261. Electrofusion fittings shall comply with ASTM F1055. Mechanical fittings produced from material not listed in paragraph A above, shall be approved only after submission of appropriate test data and service histories indicating their acceptability for the intended service. In all cases, the specifications and requirements of the fittings supplied shall comply with the appropriate section of AWWA C901, C906, or CSA B137.1.

7) **Pressure Class**

The Pressure Class of the Polyethylene pipe and fittings shall be specified on the basis of the Working Pressure Rating of the water system as defined in AWWA C906. Recurring positive pressure surges of up to one half of the pipe's nominal pressure class and occasional pressure surges of up to 100% of the pipe's nominal pressure class may be ignored due to the fatigue endurance of the polyethylene materials. Non-polyethylene fittings shall be specified and used in accordance with the surge tolerance of the particular appurtenance in use.

8) **Marking**

Pipe and tubing shall be marked in accordance with either of AWWA C901, AWWA C906, or CSA B137.1, whichever applies. Marking shall be legible and shall remain legible under normal handling and installation practices. Indent marking may be utilized provided; 1) the marking does not reduce the wall thickness to less than the minimum value for the pipe or tubing, 2) it has been demonstrated that these marks have no effect on the long term strength of the pipe or tubing and, 3) the marks do not provide leakage channels when elastomeric gasket compression fittings are used to make the joints.

Fittings shall be marked on the body or hub. Marking shall be in accordance with either ASTM D2683, ASTM D3261, AWWA C906, or ASTM F1055, depending on fitting type and the standard that applies. Mechanical fittings shall be marked with size, body material designation code, pressure rating and manufacturer's name or trademark.

9) **Workmanship**

Pipe, tubing, and fittings shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, blisters, dents, or other injurious defects. The pipe, tubing, and fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical prosperities.

F. **PVC PIPE FOR SERVICE CONNECTIONS**

Pipe for 4-inch and 6-inch service connections shall be schedule 40 solid wall PVC pipe with solvent cement weld joints meeting ASTM D1785, *Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120* and ASTM D2564, *Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.* In-line wyes shall be used for all service connections to new lines. Connections to existing mains shall be made by the use of an approved saddle with stainless steel band. Use of saddles for service connections shall be approved by the Town Engineer on a case-by-case basis. The service shall include the in-line wye, bends, long sweep wye, and clean-out stack provided with a brass clean-out plug. See **Standard Detail 533.01**.

G. **SERVICE SADDLES:**

Sewer pipe saddles shall be DFW/HPI model DFW-4Y or NDS model 4Y-C or approved equal. See **Standard Detail 533.02**.

2.1.3 STEEL PIPE (Use of steel pipe - approved on a case-by-case basis)

A. **STEEL PIPE FOR SEWER MAINS, AERIAL CREEK CROSSINGS, ENCASEMENT, BORING APPLICATIONS, AND VENT PIPES:**

Pipe shall be unwrapped high strength steel, spiral welded or smooth-wall seamless manufactured in accordance with ASTM A139 *Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over) and ASTM A283/A283M Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates,* Grade "B" steel with a minimum yield strength of 35,000 psi or ASTM A252 *Standard Specification for Welded and Seamless Steel Pipe Piles*, Grade 2 steel with a minimum yield strength of 35,000 psi. All encasement pipes shall meet the applicable NCDOT, Municipal, or AREA specifications but shall be no less than 6 inches larger than the outside diameter of the carrier pipe bell. The steel pipe shall be capable of withstanding the design load. No interior lining and exterior coating shall be required except that all exposed metal is to be coated with epoxy or asphaltic material. The pipe shall have welded joints and be in at least 18-foot lengths.

1) **Steel Pipe for Gravity Sewer Mains**: Pipe shall be seamless and either furnace-welded or electrically welded pipe, Grade A. The exterior coating shall be coal-tar enamel in accordance with AWWA C203.

2) **Steel Pipe for Aerial Creek Crossings** (*without encasement and carrier pipe*): The outside of the pipe shall have one coat of zinc chromate primer conforming to Federal Specification TT-86-a and afterwards painted with coal-tar enamel.

3) **Steel Encasement Pipe for Boring Applications:** Encasement pipe shall meet applicable NCDOT and AREA specifications. Casing pipe shall include pipe carriers (spiders) to support carrier pipe.

   a. **Spiders/Skids for Encasement Pipes**: Steel Spiders/Skids shall be as manufactured by ITT Grinnell, Charlotte, NC; Spider Manufacturing, Durham, NC; Advanced Products & Systems (APS)

model SSI with EPDM skids, Lafayette, LA, or approved equal. See paragraph 3.1.4B and **Standard Detail C07.01** for location of spiders. For bolted connections, bolts shall be either galvanized or stainless steel

b. **Steel Casing End Seals**: Casing end seals shall be 1/8" thick synthetic rubber seamless pull-on end seals with T-304 stainless steel banding with 100% non-magnetic worm gear mechanism. End seals shall permit pipe movement while maintaining a seal. Acceptable manufacturers are: Advance Products & Systems, Inc., Lafayette, LA, or equal

4) **Steel Vent Pipes for Sanitary Sewer Manholes**: The vent pipe shall be made from Schedule 40 Stainless Steel. See **Standard Detail 532.10**.

2.1.4 TUNNEL LINERS

A. Carrier pipe shall be mechanical joint or restrained joint ductile iron pipe pressure class 350 psi.

B. Grout mix for filling voids in between carrier pipe and tunnel shall consist of the following materials properly mixed in proportions by weight.

1) 1.0 Part Cement.

2) 3.0 Parts Fine Sand, 100 Percent Shall Pass No. 16 Sieve.

3) 0.5 to 0.6 Part Water – water should be sufficient to provide a consistency of thick cream when well mixed.

4) 2% approved additive (Bentonite, Septamine Seaex, Hydrocide liquid, etc.).

C. Tunnel lining construction shall comply with the "*Specification for Steel Tunnel Liner Plates"* in the American Railway Engineering Association (AREA) Manual for Railway Engineering, latest revision and AASHTO Standard Specification for Highway and Bridges, latest edition. The design and shape of the liner plates shall be such that erection and assembly of the liner plate structure can be completely and readily effected from inside the tunnel. Plates shall be accurately curved to suit the tunnel cross section, and all dimensions shall be of the size and accuracy such that plates of similar curvature shall be interchangeable. All plates shall be connected by bolts on both longitudinal and circumferential joints.

D. The steel lining shall consist of plates 16, 18, or 24 inches wide. Each circumferential ring shall be composed of the number and length plates necessary to complete the required shape shown on the drawings. The nominal tunnel diameter shall be of sufficient size to install the carrier pipe.

E. Plates shall be one-piece steel meeting the requirements of ASTM A1011 *Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength*, or ASTM A1008 *Standard Specification for Steel,*

Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable. Plates shall have an ultimate tensile strength of at least 42,000 psi and yield strength of 28,000 psi. Nominal plate dimensions shall provide the sectional properties shown in Article 1.13.9 (or latest update) of the AASHTO Standard Specifications for Highway Bridges. Thickness tolerances shall conform to Paragraph 14 of AASHTO M167 *Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches*. Gage thickness shall be a minimum of 8 gage. The liner plate and bolts shall be galvanized in accordance with ASTM A153 *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*. In addition, the liner plates shall be asphalt coated to meet AREA Article 1.14.13 (or latest update). For two flange plates, the minimum thickness shall be 0.135 inches. Plates shall be manufactured by Armco Steel Corporation, Commercial Shearing, Incorporated, Republic Steel Corporation, or equal.

F. Grout holes 1½ inches or 2 inches (or larger) in diameter shall be provided in each ring to permit grouting as the erection of the tunnel liner plates progresses. Grout hole screw plugs shall be provided in plates.

   The minimum provision for grouting openings shall be one opening in a top plate of the tunnel at locations not to exceed 54" apart. Additional plates with grouting openings are to be installed at the top quarter points on each side between the top openings. The opening shall be staggered, but shall not exceed 54" in any one line. Grout vent pipes will be required at a minimum of one per monolithic pour.

G. Steel bolts shall meet requirements of ASTM A449 *Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use* for plate thickness equal to or greater than 0.209 inch and ASTM A307 *Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength* for plate thickness less than 0.209 inch. The nut shall meet requirements of ASTM A307, Grade A.

2.1.5 CARRIER PIPE FOR CASINGS AND TUNNELS

Carrier pipe shall be mechanical joint ductile iron pipe of the class indicated on the drawings. See paragraph 2.1.1, Ductile Iron Pipe.

2.2 MISCELLANEOUS APPURTENANCES AND MATERIAL

2.2.1 GATE VALVES

Gate valves shall follow the specifications as written in **Section 02510** – *Water Distribution*, paragraph 2.2.6.

2.2.2 PLUG VALVES

Plug valves shall be non-lubricated, eccentric type with resilient faced plugs and with mechanical joint ends for buried service. Port area shall be at least 80% of the full pipe area. Bodies shall be semi-steel or cast iron. Seats shall have a welded in overlay of not less than 90% pure nickel on all surfaces contacting the plug face. Valve shall have stainless steel permanently lubricated upper and

lower plug stem bushings. Valves shall be of the bolted bonnet design, and shall be designed so that they can be repacked without removing bonnet from valve. All nuts, bolts, springs, and washer shall be cadmium plated.

All plug valves 6" and greater shall be equipped with an actuator. All gearing shall be enclosed, suitable for running in oil, and the actuator shall be submersible with seals provided on all shafts to prevent entry of water into actuator shall clearly indicate valve position and an adjustable stop shall be provided with a nut operator and extension stem of suitable length.

Valves shall be as manufactured by Dresser, DeZurik, Keystone, Kennedy or approved equal.

2.2.3 VALVE BOXES

Gate valves shall follow the specifications as written in **Section 02510** – *Water Distribution*, paragraph 2.3.14.

2.2.4 AIR RELEASE AND VACUUM VALVES

Combination air release and vacuum valves are to be used to bleed air during filling of force mains and to automatically vent air that collects in the force mains. The valve shall be a NPT threaded cast iron body with a stainless steel float assembly and stainless steel trim. The valve outlet is to be protected from debris entering the outlet of the valve. Plumbing valves shall be all brass. The air release and vacuum valves shall be furnished with a back flushing hose with quick disconnect and brass valve assembly. Valves shall be designed for a maximum cold water pressure of 300 psig. Combination air release and vacuum valves shall be located as shown on the drawings or as otherwise directed by the Town. The valve shall be housed in a precast concrete manhole and shall be installed in accordance with **Standard Detail 534.06**. Acceptable manufacturers are the Cripsin S/SL series as manufactured by Multiplex Manufacturing Co., Berwick, PA and the Fig. 955 as manufactured by the Empire Valve Company, Cranberry Township, PA, or an approved equal.

2.2.5 BEDDING

A. Bedding material, shall be clean coarse aggregate No. 57 or smaller, and shall meet the requirements of Section 1005 of the NCDOT Standard Specifications for Roads and Structures.

1) **Minimum Bedding Allowed**: The minimum bedding depth shall be 3 inches under the pipe with an additional 1 inch depth of cushioning material added for each additional 2 feet of depth in excess of 16 feet up to a maximum of 12 inches of cushioning material. Pipe shall be bedded to the spring line of the pipe. See **Standard Detail 531.01**.

2.2.6 SOLID BRICK (for modifications to manholes)

Sold brick shall be hard clay, grade SM, ASTM C 32, *Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)* and AASHTO M91.

2.2.7 CONCRETE

Concrete classes (NCDOT) to Design Compressive Strength at 28 days (f'c):

Class	28-day Compressive Strength (f'c)
AA	4500 psi
A	3000 psi
B	2500 psi

Ready mixed concrete shall comply with ASTM C94, *Standard Specification for Ready-Mixed Concrete.* All exposed concrete shall be air entrained. Concrete strength shall be as specified on the Standard Details and drawings. Unless otherwise specified, all concrete shall be minimum class A.

2.2.8 CONCRETE BLOCK (for manholes)

Concrete block shall conform to the requirements of ASTM C139, *Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes*.

2.2.9 MORTAR FOR CONCRETE BLOCK & CLAY BRICK

Mortar shall be type M, ASTM C 270, *Standard Specification for Mortar for Unit Masonry* and ASTM C-144, *Standard Specification for Aggregate for Masonry Mortar.* Mortar shall be prepared from cement in perfect condition and shall be prepared in boxes for that purpose. No mortar that has stood beyond forty-five minutes shall be used. Proportion by volume for the different types of application shall be as follows:

Brick masonry = 1 part cement to 2 parts sand

Pointing = 1 part cement to 1 part sand

2.2.10 IRON CASTINGS: MANHOLE FRAMES AND COVERS

A. **General**: Manhole frames and covers shall be manufactured from Class 35B gray iron, meeting the requirements of ASTM A48*, Standard Specification for Gray Iron Castings,* as noted in section 3.1 of AASHTO M306. Standard manhole frames and covers shall be built to the dimensions and configurations shown on **Standard Details C06.01** and **C06.02.** Minimum inside diameter of the opening shall be 23 ½ inches. Manholes castings are to be uncoated. The bearing surface of the frames and covers shall be machined and the cover shall seat firmly into the frame without rocking. Covers are to be embossed along the perimeter with the name "TOWN OF CLAYTON" and with the words "Sanitary Sewer" and "Confined Space." See **Standard Details C06.01** and **C06.02**.

Watertight Frames and Covers: Watertight bolt-down frames and covers shall have 4 stainless steel bolts at 90 degrees. Frame is to have (4) 1-inch diameter holes in flange at 90 degrees. Bolt down frames and covers are to be utilized whenever a manhole top is set lower than 1-foot above the 100-year base flood elevation.

B. Approved castings are:

Manufacturer	US Foundry	East Jordan Iron Works
Standard Model	700KL	V-1384
Watertight Model (Bolt-Down)	669-KL-BWT	V-2384
Cover Weight	125	135
Frame Weight	190	180

Note: Weights shall not deviate by - 5% from that shown in the above table.

If the top of the manhole is less than 1-foot above the 100-year base flood elevation, a bolt-down watertight frame and cover is to be used.

C. **Bolting Down Watertight Frames to Manhole**: For units not cast into the manhole top, frame shall otherwise be drilled and bolted into cone sections with a minimum of 4 bolts. Bolts shall be stainless steel expansion bolts by manufacturers such as Hilti, Rawl or Liebig. This requirement shall apply for watertight frames and covers only. See **Standard Detail C06.02**.

2.2.11 IRON CASTINGS: SEWER CLEANOUT BOX

General: Sewer cleanout frames and covers shall be manufactured from Class 30 gray iron, meeting the requirements of ASTM A48, *Standard Specification for Gray Iron Castings*. Standard sewer cleanout frame and covers shall be built to the dimensions and configurations shown on **Standard Detail 533.01**. Casting shall be Russco model MBX 348 Valve Box or an approved equal.

2.2.12 MANHOLE (PRECAST) EXTERIOR JOINT SEALANT

Manhole castings shall be sealed to the structure with an external sealing system such as **Infi-Shield**®. The seal shall be continuous bands, made of high quality EPDM (Ethylene Propylene Diene Monomer) rubber with a minimum thickness of 60 mils. Each unit shall have a 2-inch wide mastic strip on the top and bottom of the band. The mastic shall be non-hardening butyl rubber sealant, with a minimum thickness of 3/16-inch, and shall seal to the cone/top of the manhole and over the lip of the casting. See **Standard Detail 532.11**.

2.2.13 MANHOLE FLEXIBLE INTERIOR COATING SEALANT (FLEX-SEAL)

Internal sealant system shall prevent leakage of water into the manhole though the frame joint area and the area above the manhole cone including all extensions to the chimney area. The seal shall remain flexible allowing for repeated vertical or horizontal movements of the frame due to frost lift, ground movement, or the thermal movement of pavement. The product shall have a minimum elongation of 800% and a Durometer hardness of 75. The manhole sealant shall conform the physical requirements of ASTM D412 *Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension* with a minimum of 170 mils thickness for durability and resistance elongation and tearing. The lining product shall have an aromatic urethane primer resin on the complete surface. Sealant shall equal or exceed

"Flex-Seal" as manufactured by Sealing Systems, Inc., Loretto, MN. See **Standard Detail 532.11**.

2.2.14 MANHOLE INSIDE DROP BOWLS

Manhole inside drop bowls to be highly resistant to sewer acids and constructed from marine grade fiberglass finished in bright white gel coat. Bowls shall equal or exceed drop bowls manufactured by RELINER/Duran, Inc. The drop bowls size shall be determined by incoming pipe size and flow rates for retrofit or new construction. The bowl shall be installed as per manufacturer's instructions. The connection of the drop bowl to drop pipe shall be by flexible external pipe coupler.

Clamping pipe supports to be manufactured from 11 Ga. non-magnetic 304 stainless steel with 18-8 stainless steel nuts and bolts.

2.2.15 MANHOLE MARKERS

Furnished by Town, installed by Contractor. See **Standard Detail 532.03**.

2.2.16 PORTLAND CEMENT

Type I, CSA normal, ASTM C150 *Standard Specification for Portland Cement*.

2.2.17 PRECAST REINFORCED CONCRETE STRUCTURES

A. Manholes of precast reinforced concrete shall be designed and manufactured in accordance with ASTM C478, *Standard Specification for Precast Reinforced Concrete Manhole Sections*, or latest revision. Manhole diameters shall be 4-ft. minimum. The wall shall be a minimum of 5 inches thick and have a 6-inch minimum base. Either an "O" ring or "ram neck" joint seal shall be used. The "O" ring joint shall conform to the requirements of ASTM C443*, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets* or latest revision. The gasketed joint shall conform to ASTM C990, *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants* (or AASHTO M-199) or latest revision. Rubber boot and stainless steel clamps, meeting the requirements of ASTM C923, *Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals*, shall be supplied with the manhole bases to tie the pipe to the base section of the manhole. Concrete used in the construction of the manholes shall have a minimum 28-day strength of 4000-psi air entrained (with 4 to 6 percent air) conforming to ASTM C33*, Standard Specification for Concrete Aggregates* and ASTM C94/C94M, *Standard Specification for Ready-Mixed Concrete*. Manhole units shall consist of standard modular precast riser sections, modular riser sections, and a monolithic base (except doghouse bases are to be used when placing manholes over existing mains). Where conditions do not favorably accommodate the use of an eccentric cone, eccentric precast reinforced concrete flat tops are to be used. In areas of high H_2S concentration, provide protection of manhole by providing linings or coatings on the interior of the manhole such as Polyethylene, PVC, Reinforced Thermosetting Resin (RTR), "Strong-Seal," or coal-tar epoxy.

Unless otherwise permitted by the Town, manholes will be precast reinforced concrete. Brick or block manholes are not permitted.

Refer to the **Standard Detail 532.01** for boot to pipe connection detail.

Extended Bases: Manholes over 12 feet in depth, as measured from top of casting to effluent invert, shall have extended bases with appropriate reinforcing. Also, manholes over 12 feet in depth shall also be a minimum of 5-foot diameter. See **Standard Detail 532.03** and **532.05**.

Joint Seal: All buried joints shall also have an **Infi-Shield**® external sealing system placed around the exterior perimeter of the manhole joint. See **Infi-Shield**® specification elsewhere in this specification. See also **Standard Details 532.03, 532.05,** and **532.07**.

B. **Manhole Steps**

Manhole steps shall be steel reinforced polypropylene. Steps shall have a footing surface at least 10 inches wide and shall protrude at least 5 inches away from the manhole wall. The step surface shall have a tread plate or other safety surface. Steps shall be provided on 16 inch centers and be located directly below the manhole cover on the eccentric cone section. Steps shall be located directly over the outlet pipe on the base.

C. **Flexible Pipe-to-Manhole Connector**: A flexible Pipe-to-Manhole connector shall be employed in the connection of the sanitary sewer to precast manholes. The connector shall be *KOR-N-SEAL*, as manufactured by NPC, Inc., Milford, New Hampshire, *PSX*, or equal.

The connector shall be the sole element relied on to assure a flexible watertight seal of the pipe to the manhole. No adhesives or lubricants shall be employed in the installation of the connector into the manhole. The rubber for the connector shall comply with ASTM C923 *Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals*, and consist of EPDM and elastomers designed to be resistant to ozone, weather elements, chemicals, including acids, alkalis, animal and vegetable fats, oils and petroleum products from spills.

All stainless steel elements of the connector shall be totally non-magnetic Series 304 Stainless, excluding the worm screw for tightening the steel band around the pipe, which shall be Series 305 Stainless. The worm screw for tightening the steel band shall be torqued by a breakaway torque wrench available from the precast manhole supplier, and set for 60-70 inch/lbs.

Flexible sleeve boots shall not be used with concrete pipe or on pipe larger than 18 inches in diameter. Boots shall have either a serrated flange of the boot cast into the manhole wall or an expanding stainless steel interlocking sleeve to compress the boot against a cast or core hole (PSX, KOR-N-SEAL or equal) may be used. Mechanical expansion of the interlocking ring shall be done in accordance with the manufacturer's recommendations.

The connector shall be of a size specifically designed for the pipe material and size being utilized on the project.

Refer to **Standard Detail 532.01** for boot to pipe connection detail.

D. **Joints at Existing Manholes (Clay Brick and Concrete Brick)**

For 12 inch and smaller pipe, a virgin PVC waterstop concrete manhole adapter (Fernco Joint Sealer Company - CMA series or equal), sized for the respective pipe, shall be placed over the pipe, centered horizontally within the manhole wall and the space between the pipe and manhole completely filled with non-shrink grout (water plug or approved equal).

For 15-inch and larger sewers, the annular space shall be complete filled with nonshrink grout. Standard brick and mortar shall then be place completely around the pipe outside the manhole, supported on the extended base and entirely coated with at least 3/4 inch of mortar. Particular care shall be exercised in placing the bedding in order to achieve adequate and uniform support of the manhole and the pipe through the first joint outside the manhole.

2.2.18 TRANSITION COUPLINGS

A. Where it is necessary to join different types of pipe (e.g. DIP to SDR 35 PVC, and approved by the Town, rigid couplings encased in stone shall be used. Couplings shall conform to the applicable proportions of ASTM C425, *Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings, ASTM* C443, *Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets*, ASTM D1869, *Standard Specification for Rubber Rings for Asbestos-Cement Pipe*, ASTM A746, Standard Specification for Ductile Iron Gravity Sewer Pipe, & ASTM D3034, D3034, *Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings*, ASTM D2680, *Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Pipe*, & AWWA C900, *Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in.*

B. The following are acceptable couplings (or approved equal):

Manufacturer	Type/Model
Smith-Blair	461
Clow Corp. (M&H)	F203 or F1213
Romac	XR 501

C. **Poured concrete collars are not permitted**.

D. Fernco couplings are not permitted.

2.2.19 WARNING TAPE AND LOCATOR WIRE

A. **Metallic underground warning tape**: Metallic detectable underground warning tape shall consist of a solid aluminum foil core, 35 gauge minimum, encased on each side with plastic (minimum overall thickness 5 mils) and be 3 inches wide with black lettering imprinted on a color coded background that conforms to APWA uniform color code specification (BLUE) and silver with black ink letters. Minimum tensile strength shall be 22 lbs/inch. Soil tolerance range to be pH 2.5 to pH 11.0. On one side of the tape, the text shall include the wording “SEWER LINE BELOW” repeated along the length of the tape. A detectable warning tape shall be used with all water mains. Underground warning tape is to be placed

directly over the pipe 12 to 18 inches below the finished grade. See **Standard Detail 511.01**.

Standard color code for tape and wire.

Green: Sewer Systems

B. **Locator Wire (for Force Mains)**: #12 AWG blue insulated solid copper wire shall be installed above all water and sewer mains. Electrical conductivity along the pipe shall be continuous and uninterrupted between valve boxes. Clamps used to bond wire to conductor to metal (in instances where both PVC and ductile iron are used in the same run of pipe) shall be heavy-duty stainless steel approved by the Town Engineer. A sufficient excess length of wire shall be left in each valve box to provide at least a 6 to 12 inches length of wire above finished grade. See **Standard Details 513.01 and 513.03**.

2.2.20 TRACING WIRE STATION – LOCATOR POST

Tracing wire stations are to be high visibility plastic posts with two external terminals. The posts shall be green and specifically designed for outdoor use with UV stabilizers that keep the colors bright and resist fading. The plastic blend is to be formulated to keep the post from becoming brittle in the winter and from softening in the summer heat. Tracing wire stations shall equal or the Rhino TriView Flex Tracing Wire Station model MB-70429.

2.2.21 WETWELL/VALVE VAULT ACCESS HATCHES

A. **Non-Traffic Areas**: The aluminum access frames and covers are manufactured with 1/4-inch thick, one-piece aluminum extruded frame, with a continuous concrete anchor as part of the one-piece extrusion. The door panels are 1/4-inch thick aluminum diamond plates, to withstand a live load of 300 lbs. per square foot, with a safety factor of times 1.5. The doors are provided with stainless steel hinges with tamper-proof fasteners. All hardware is stainless steel. The doors open to 90 degrees and lock automatically in that position with a stainless steel positive locking arm and a stainless steel release handle. Doors are provided with a stainless steel lifting handle, stainless steel locking bar, or stainless steel snap-lock with removable key handle. Two key handles shall be provided with each door. The doors will close flush with the top of the frame, resting on a 1/2-inch wide lip around the entire inside of the frame for added support. Provide padlock hasp for doors on wetwells and valve vaults. A fall protection net is required on wet wells.

Vaults in pedestrian areas shall have recessed latch.

B. **Traffic Areas** – Vaults not permitted in traffic areas.

C. **Guarantee and Manufacturer**: The aluminum access frames and covers shall carry a 10-year guarantee against defects in materials and workmanship. The frame and cover shall equal or exceed the units manufactured by the following:

Manufacturer	Valve Vault (36"x 36" Min.)	Wetwell
The Bilco Company	J-4AL	JD-2AL (4'x4') min
Halliday Products, Inc.	S1R	W2S4848 min
US Foundry & Manufacturing Corp.	APS 36x36 w/OP	THD 48x48 w/OP min.

2.2.22 YARD FLUSHING HYDRANTS

2-inch yard flushing hydrants shall equal or exceed the Eclipse No. 2 Post Hydrant as manufactured by the Kupferle Foundry Company. See **Standard Detail 514.08**.

PART 3 – EXECUTION

INSTALLATION – PIPE AND FITTINGS

3.1 PIPE AND FITTINGS

3.1.1 CONSTRUCTION – ALL PIPE

A. **Trench width shall be per Standard Detail 531.01**.

B. **Protection of Existing Sewers**: Sewer lines under construction shall be plugged with a mechanical plug at the first manhole upstream from the point of connection. Plug shall be placed in the outlet connection and secured with a steel cable. Plug shall remain in place until acceptance of lines by the Town's authorized representative. Water, stone, dirt, or any other debris shall not be allowed to enter the Town's sanitary sewer system during flushing operations or at any other time. Construction taking place in the vicinity of any existing Town sewer lines or manholes shall not cause any inflow of surface water or debris to enter the Town's sanitary sewer system. Existing Town manholes located in construction sites are to remain accessible at all times. The Owner and/or Contractor shall be responsible for any damages incurred to the Town's sanitary sewer system and any fines imposed by NCDENR, Division of Water Quality due to sewer spills or overflows.

C. **Pipe Laying Direction**: Place piping beginning at low point and progress uphill. Place on grade, with unbroken continuity in invert, horizontally and vertically, and on alignment as indicated on plans. Place bell ends of piping facing upstream. Install gaskets, seals, sleeve, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

D. **Directional changes in gravity lines**: Use manholes for changes in direction of gravity lines.

E. **Handling New Pipe**: Lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying. The pipe shall not be dropped or unloaded by rolling. Care should be taken not to let the pipe strike sharp objects while swinging or being off loaded. Ductile iron pipe should never be placed on grade by use of hydraulic pressure from an excavator bucket or by banging with heavy hammers.

F. **Stringing out Pipe**: Only the amount of pipe that will be used in one day may be strung out. When pipe is strung out, it shall be set on high ground and in a position to prevent silt deposits, storm water, or other matter from entering the pipe prior to its placement in the trench.

G. **Pipe Laying**: The foundation for sewer pipe shall be a firm flat bottom trench with a minimum of 3-inches of compacted stone for gravity sewer mains. The pipe and fittings shall be laid in the trench so that its interior surface shall conform to the grade and alignment as shown on the plans. Pipe laying shall be done in such a way as to disturb as little as possible the pipe that has already been laid. The alignment and grade of the sewer main may be field adjusted whenever, in the opinion of the Town, it is necessary, so long as the adjustments are within that allowed by NCDENR based on regulations in affect at the time of the change and so long as the changes are consistent with Town's policy in affect at the time of the change. Changes in either grade or alignment may only occur at manholes.

Before laying, the bell and spigot will be wiped free from any dirt or other foreign matter. All surfaces of the portion of the pipe to be joined, and the factory-made jointing material, shall be clean and dry. Lubricants, primer, adhesives, etc., shall be used as recommended by the pipe or joint manufacturer's specifications. The jointing material or factory-fabricated joints shall then be placed, fitted, and adjusted in such workmanlike manner as to obtain the degrees of water tightness required.

Trenches shall be kept as dry as possible during bedding, laying and jointing and for as long a period as required until the trench is backfilled. As soon as possible after the joint is made, sufficient bedding material shall be placed along each side of the pipe to offset conditions that might tend to move the pipe off line or grade. The greatest care shall be used to secure water tightness and to prevent damage to or disturbing of the joints during the backfilling process, or at any other time.

All special fittings, such as wyes and other connections, shall be installed at the points indicated on the plans, in accordance with the Standard Detail drawings. Use appropriate adaptors to tie connection pipe to wyes or saddles. Plug end of connection with appropriate plug.

After the trench foundation has been properly graded to receive the pipe, the pipe shall be carefully lowered into the trench with approved methods. Under no circumstances shall the pipe or accessories be dropped or dumped into the trench. All damaged pipe shall be replaced.

Any defects due to settlement shall be corrected by the Contractor.

H. **Temporary Suspension of Work**: When the trench is left for the night or if pipe laying is suspended, the upper end of the pipe shall be plugged to keep out dirt, water, animals and other foreign matter or substances. This plug shall be kept in the end of the pipe line at all times when laying is not in actual progress.

I. **Cutting or Fitting Pipe**: Whenever a pipe requires cutting, to fit in the line or to bring it to the required location, the work shall be done in a satisfactory manner with an approved cutting tool or tools which will leave a smooth end at right angles to the axis of the pipe and not otherwise damage the pipe or liner. When

the cut end is to be assembled in a *Fastite* bell, an adequately smooth (without sharp edges) bevel should be ground or filed on the cut edge to prevent damage to or dislodgement of the gasket during assembly. The method of cutting pipe shall be in accordance with manufacturer's recommendations. No welding, flame cutting or flame tapping will be allowed. Such cuts shall be made by the Contractor.

J. **Surface Water Crossings**: Surface water crossings (wet lands, floodplains, etc.) with pipe underground shall be ductile iron pipe. Pipe material shall remain constant between manholes. No transition of pipe material between manholes is permitted.

K. **Ravine/Channel Crossings**: Ravine and channel crossings are to be perpendicular to the ravine or channel crossed. Pipe support piers, as shown on **Standard Detail 536.01**, or steel girders, as applicable, shall adequately support surface water crossings with pipe above the water. Kraft paper shall be placed between pipe and all points of contact with concrete and stainless steel straps. Disturbed banks are to be stabilized with rip rap placed over a non-woven fabric.

L. **Crossing Conflicts**: All drains, gutters, culverts, and sewers for surface drainage are to be kept open or if unavoidably closed, other provisions are to be made for this drainage.

3.1.2 DUCTILE IRON PIPE

A. **CONSTRUCTION:**

Gravity DIP shall conform to the same foundation and backfill requirements as those prescribed for water mains. Minimum laying length shall be 18 feet except for tie-in at a structure. However, bury limitations shall govern as follows:

Table 02530.1
Bury Limitations on DIP

Pipe	Maximum Bury to Invert of Pipe
8-inch DIP thru 24 inch Thickness Class 50	18 feet (need Town's approval if > 18 feet)

See **Standard Detail 531.01** for sewer DIP laying conditions.

B. **MECHANICAL JOINT BOLT TORQUE:**

Where mechanical joint fittings are required, unless otherwise advised by the manufacturer, the minimum bolt torque shall comply with Table 2 of AWWA C600 for mechanical joints, as follows:

Bolt Size (Inches)	Torque (Ft-Lbs)
5/8	45-60
3/4	75-90
1	100-120
1 1/4	120-150

C. See also Section 02275 – Trenching, Backfilling, and Compaction of Utilities.

D. Minimum cover shall not be less than 3 feet.

3.1.3 PVC PIPE

A. Installation shall comply with *Underground Installation of Flexible Thermoplastic Sewer Pipe*, ASTM D2321, *Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications*. Installation of PVC Truss Pipe shall comply with ASTM D2680 *Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping,* Appendix XI, or latest revision.

B. **Bury Limitations**:

Table 02530.2		
Bury Limitations on all PVC		
Pipe	**Bedding**	**Maximum Bury to top of pipe**
SDR 35 PVC	Class B-1 w/ DOT # 57 or #67 stone	Per Uni-Bell Handbook
PVC C900/C905	Class B-1 w/ DOT #57 or #67 stone	Per Uni-Bell Handbook

Minimum cover shall not be less than 3 feet.

3.1.1 HORIZONTAL DIRECTIONAL DRILLING OF HDPE PIPE FORCE MAINS

A. HDPE pipe shall be installed by Horizontal Directional Drilling (HDD) using a surface mounted rig, first to drill a guided hole along a bore path consisting of a shallow arc and then to pull a string of pipe into the hole. Pull back is facilitated by a back-reamer, which enlarges the hole to approximately one and a half times the pipe diameter. Drilling fluids are injected into the bore hole to stabilize the hole and lubricate the pipe and drill-string. Tracking equipment is used to guide and direct the drilling.

1) Mechanical Restraint

When Polyethylene pipe is pressurized, it expands slightly and shortens slightly. Shortening may be enough to disjoin unrestrained mechanical joints that are in line with PE pipe. Disjoining can be prevented by installing external joint restraints at mechanical connections, by installing line anchors, or by a combination of both. Contractor shall install mechanical connections with joint restraint at each connection to mechanical joint pipe.

Note: Poisson Effect pipe shortening must be taken into account whenever the pipe is pressurized, both during the pressure testing, and when it is placed in service. Because pressures are usually higher during pressure testing (up to 150% of the system pressure rating), pipe expansion and Poisson Effect pipe shortening may be slightly greater during pressure testing. Before pressure testing, all mechanical joint restraints must be completely installed and secured per manufacturer's instructions. Concrete in-line anchors and thrust blocking (if used) must be fully cured (minimum of 21 days for 3,000 psi or 7 days for 4,500 psi

concrete) and properly backfilled before testing. Restraint is not required at PE to PE butt fusion joints. Restraint is not required at bolted flanged joints.

Mechanical coupling: Stainless steel internal stiffeners shall be used on all couplings to increase the seal. All couplings shall have restraint devices per the manufacturer's recommendation and installed per the Manufacturer's direction.

B. **Installation and Testing**

The Manufacturer shall supply an Installation Manual to Town Engineer, which outlines guidelines for handling, joining, installing, embedding, and testing of the Polyethylene Pipeline. These guidelines shall be used as reference material by Town's Engineer in his determination of the required procedures.

Joints between plain ends of Polyethylene pipe shall be made by butt fusion when possible. The pipe manufacturer's fusion procedures shall be followed at all times as well as the recommendations of the fusion machine manufacturer. The wall thicknesses of the adjoining pipes and fittings shall have the same DR at the point of fusion.

When saddle connections are fusion welded, the Manufacturer's recommended saddle fusion procedures shall be used.

If mechanical fittings (which are designed for, or tested and found acceptable for use with Polyethylene pipe) are utilized for transitions between pipe materials, repairs, joining pipe sections, saddle connections, or at other locations; the recommendation of the Mechanical Fitting manufacturer must be followed. These procedures may differ from other pipe materials.

On each day butt fusions are to be made, the first fusion of the day shall be a trial fusion. The trial fusion shall be allowed to cool completely, and then fusion test straps shall be cut out. The test strap shall be 12 inches long or 30 times the wall thickness in length (minimum) and 1 inch or 1.5 times the wall thickness in width (minimum). Bend the test strap until the ends of the strap touch. If the fusion fails at the joint, a new trail fusion shall be made, cooled completely, and tested. Butt fusion of pipe to be installed shall not commence until a trail fusion has passed the bent strap test.

Socket and Straddle fusions shall be tested by a bent strap test as described by the Pipe manufacturer. The pipe manufacturer shall provide visual guidelines for inspecting the butt, saddle, and socket fusion joints.

Pressure testing shall be conducted in accordance with manufacturer's recommended procedure. Pressure testing shall use water as the test media. Pneumatic testing is prohibited.

C. **Shop Drawings**

Contractor shall submit shop drawings and details on the proposed HDPE pipe, fittings, bore methods, etc., for review and approval of Town Engineer before ordering material or beginning installation of the HDPE. Contractor shall also submit to Town Engineer proposed subcontractor's name as well as references

on which he/she plans to use on this project. All subcontractors/installers must be approved by Town Engineer.

3.1.4 STEEL PIPE

All operations of the Contractor shall be subordinate to the free and unobstructed use of the right of way of the passage of traffic without delay or danger to life, equipment, or property.

A. **AERIAL PIPE:**

Where required, steel aerial pipe shall meet the length, thickness, and diameter shown on the plans.

Pipe is to be joined by welding. The pipe shall be beveled and prepared for field welding at the circumferential joints. Joining of steel pipe shall meet the requirements of AWWA C206, *Standards for Field Welding Steel Water Pipe Joints.*

Kraft paper shall be placed between pipe and all points of contact with concrete and stainless steel straps. Upon completion of installation, paint the exterior of the pipe with coal tar enamel. See section 2.1.3 of this specification.

B. **ENCASEMENT PIPE:**

General: Where required, steel encasement pipe shall meet the length as shown on the plans and the thickness and diameter as shown on **Standard Detail C07.01**. Boring across roads and railways shall be performed by dry boring and jacking a steel encasement pipe under the pavement or rail. The encasement shall be located in an area that is relatively free from material such as rock and stone that may hamper the boring operation. If requested by the Town Engineer, the Contractor shall submit a complete plan and schedule for pipe installation prior to the commencement of such work. The submission shall include complete details of the sheeting, shoring and bracing for the protection of the roadbed and the materials and equipment pertinent to the boring operation. The Contractor shall not proceed with the pipe installation until he has received approval of the plan and schedule from the Town Engineer.

Construction shall be executed in such a manner as to prevent settlement of the ground surface above the pipeline. The installation of the pipeline shall follow the heading or tunneling excavation as closely as possible.

All operations of the Contractor shall be subordinate to the free and unobstructed use of the right of way of the passage of traffic without delay or danger to life, equipment, or property. Installation shall be in accordance with of the *NCDOT Standard Specifications for Roads and Bridges, latest revision* or AREA, as applicable.

The pipe shall be plain end, mill beveled for field butt welding, unwrapped steel pipe and prepared for field welding at the circumferential joints. Joining of steel casing pipe shall meet the requirements of AWWA C206, AWWA *Standard for Field Welding of Steel Water Pipe*. Field welded joints shall be performed by AWS D.1.1 certified welders and shall be full penetration single vee groove, butt type welds around the entire circumference of the pipe. The pipe shall be in at

least 18-foot lengths. Casing shall be installed by either dry boring and jacking or open cut, as indicated on the drawings.

Encasement ends shall be enclosed as shown on **Standard Detail C07.01**. The steel encasement pipe shall be of leak proof construction. All exposed metal is to be coated with epoxy or asphaltic material.

Encasement ends shall be enclosed as shown on **Standard Detail C07.01.**

Creek Crossings: Sewers crossing creeks shall be encased in a steel casing with concrete anchors placed at each end of steel casing. Depending on clearance from stream bed, Town Engineer may require full concrete encasement of steel casing on sewer lines. Concrete anchors shall be set to provide a minimum of 12 inches of projection beyond the anchor for attachement of end seals. Creek crossings chall conform to **Standard Detail C07.02.**

Manufactured Spiders/Skids: The spiders necessary to support the carrier pipe inside of the steel encasement pipe shall be in accordance with paragraph *2.1.3A 3a, Spiders/Skids for Encasement Pipes*. Unless otherwise shown on the drawings, one spider shall be placed at each bell end and one at each spigot end (2 spiders per joint) of the carrier pipe as well as at each end of the encasement pipe (see **Standard Detail C07.01** for location of spiders).

All carrier piping shall be mechancial joint ductile iron pipe with restraint gland.

3.2 TUNNELING METHOD

A. **GENERAL**:

1) The contractor shall submit shop drawings to Town Engineer for approval prior to construction. All liner plates and ribs used in the tunnel shall be of one type. All material removed shall be disposed of off the site by the Contractor.

2) All operations of the Contractor shall be subordinate to the free and unobstructed use of the rights of way for passage of traffic without delay or danger to life, equipment, or property. The Contractor shall provide all necessary bracing, bulkheads, and shields to ensure safety to traffic at all times. The Contractor shall provide all traffic control devices as necessary and as shown on the approved traffic control plan at no additional cost.

B. **TUNNELING (BORING METHOD):**

1) Commence boring operation from a pit, with the bottom excavated to grade, and sheeted or shored if necessary. A steel pipe shall be jacked in place as a casing pipe. Boring through rock shall be oversized to allow installation of carrier pipe but no casing pipe shall be required unless liner plate is necessary for safety reasons.

2) Smoothly pave the bottom of the tunnel with concrete. Pull the carrier pipe in place a joint at a time. Securely block each section in place.

C. **TUNNELING (HAND MINING):**

1) Commence tunneling operation from a pit, with the bottom excavated to grade, and sheeted or shored if necessary.

2) All blasting shall conform to requirements for blasting in *Section 02275 – Trenching, Backfilling and Compaction of Utilities.*

3) Install the steel liner plates immediately after the excavated material has been removed, and remove the material not more than 24 inches ahead of the installed liner plates.

4) Grout all voids between the soil and tunnel liner plates. The maximum grouting pressure shall be 30 psi. Start grouting at the bottom of the tunnel liner plates and proceed upward progressively and simultaneously on both sides of the tunnel. Install liner plates no more than 6 feet ahead of grout section. Prohibit traffic over ungrouted sections of tunnel unless this section is in solid rock. Thoroughly dry-mix grout ingredients before adding water. After adding water, mix the batch for 3 minutes. Batches shall be of size to allow continuous placement of freshly mixed grout. Grout not used within 30 minutes after mixing shall be discarded. Placing shall be quick and continuous. Placement shall be under pressure with a grout pump. The period between installation of the tunnel liner plate and the placing of grout shall not exceed 7 hours, without the approval of the Town. Upon completion of grouting, fill grout plugs with provided grout hole plugs.

   A pump shall be provided for placing the grout which shall be capable of exerting sufficient pressure to assure the filling of all voids between the liner plate and the undisturbed ground. Minimum acceptable pressure to fill voids will be 5 psi. The maximum grouting pressure shall be 30 psi.

   Pumping of grout shall be done:

   i. At the completion of the installation of approximately each 6-foot of liner plate,
   ii. At more frequent intervals than 6-foot if conditions indicate the necessity, and
   iii. At the end of a work shift or for stopping of work for any reason.

5) Smoothly pave the bottom of the tunnel with concrete. After installation of the tunnel liner plates, the Contractor shall pour concrete pavement on the bottom quadrant (invert) of the tunnel, the surface of the pavement being parallel to the inner plate, with screed rails embedded in it, on line and grade for the installation of pipe in the tunnel.

6) The periphery of the tunnel shall be trimmed smooth to fit the outside of the steel liner plate as nearly as is practical, so that the void outside the plates is a minimum.

7) After installation of the tunnel liner, pull the carrier pipe in place a joint at a time. Securely block each section in place. Each joint of the carrier pipe shall be supported at two points by steel saddles or by steel spiders, strapped to the carrier pipe with steel straps. The carrier pipe shall be blocked, in place to the prevent flotation.

8) Close up tunnel liner ends to protect against entrance or foreign matter. The open ends of the casing pipe or tunnel shall be closed off by an 8-inch grout or masonry block wall prior to backfilling. A steel drain line to a 1 cubic yard French drain or to daylight shall be provided.

9) If installation is under railway tracks, all permits shall be obtained and Railway Company shall be notified prior to such installation. The same shall apply to contacting the applicable Municipality or NCDOT if installation is under a roadway.

D. See also **PART 2 – PRODUCTS**, Section 2.1.4, "*Tunnel Liners and Appurtenances.*"

3.3 MANHOLE CONSTRUCTION

A. **Standard Manholes:** Manholes shall be constructed in accordance with **Standard Details 532.01, 532.03,** and **532.07**. The Contractor shall exercise care in the ordering of manholes so that the use of grade rings for leveling and adjustments can be minimized. **Infi-Shield**® external sealing systems are to be placed on the exterior joints of manholes.

1) **Standard Manholes**: Standard manholes shall be those greater than 5 feet in depth measured from the base of the cover frame to the top of the concrete footing.

2) **Shallow manholes**: shallow manholes shall be 5 feet or less in depth measured from the base of the cover frame to the top of the concrete footing and shall be of the flat top construction (eccentric opening) and shall be capable of supporting HS-20 traffic loading.

Non-shrink grout shall be placed around pipe where pipe meets precast invert in manhole to provide for a smooth transition for sewage flow.

Manholes shall be installed plumb.

In the case of either integrally cast or expanding sleeve boots, the pipe exterior and boot interior shall be thoroughly lubricated prior to pipe insertion. The exterior of the boot under the bands shall be thoroughly lubricated with pipe soap. Puckering of boots shall not be allowed.

Flexible sleeve boots shall not be used with concrete pipe or on pipe larger than 18 inches in diameter.

When applicable, during installation of manhole, if frame and cover is near or within wheel path in roadway, turn cone to place out of wheel path.

B. **Drop Manholes:**

Interior drop manholes shall be installed per **Standard Detail 532.09**. Interior drop connections on new manholes shall consist of C900 PVC pipe and joint fittings. Interior drop connections on existing manholes shall be in accordance with **Standard Detail 532.09**. Interior drops are permitted on existing 4-foot diameter manholes.

Manholes shall conform to PART 2 - PRODUCTS.

C. **Flexible Pipe-to-Manhole Connector**: When it is necessary to field core a manhole and install a flexible Pipe-to-Manhole connector in precast concrete sanitary sewer manholes, the connector shall be installed per the manufacturer's recommendations.

D. **Precast Concrete Doghouse Manholes**: When it is necessary to install a manhole over an existing sewer main, a precast concrete doghouse manhole shall be installed over the main. A minimum of an 8-inch thick reinforced concrete base shall be poured over a #57 stone base and the doghouse manhole risers set over the existing sewer. The joint between the precast manhole and the base shall be sealed both inside and out with grout. The annular space of the precast manhole, around the main, shall be filled with grout and a shelf formed to the springline of the existing main. The crown/top of the main shall be removed once the shelf has been formed and has set sufficiently and all upstream lines tested and approved by the Town. See **Standard Detail 532.05**.

E. **Manhole Inverts**:

Manhole inverts may be formed from brick and/or 3000 psi concrete and shall be constructed a shown on **Standard Details 532.01, 532.02, 532.03, 532.05,** and **532.0**7. The depth of the channel shall be 3/4 of the pipe ID with vertical wall from the springline of the pipe up. The bench shall then be sloped to the manhole walls at ½ inch per foot. The channel shall be "U" shaped. Curved channels due to changes in pipe alignment shall be constructed in such a way as to provide gentle curves as shown on **Standard Detail 532.01**.

The internal cavity between the boot and the manhole wall will be completely filled with non-shrink grout and filleted at the manhole wall. The face where the pipe enters or leaves the manhole shall be struck smooth and the channel shall form a smooth flow line from the pipe entry to pipe exit.

F. **Installation of Manhole frames and Covers**: Frames and covers shall be installed to manhole in accordance with **Standard Details C06.01** and **C06.02**, as applicable. Frame and covers shall be installed to finished elevation. Adjustments shall be made as necessary to achieve finished elevation. On all manholes, ½-inch grout is to be placed between the frame and concrete casting or grade adjustment ring. Frames & covers are to be bolted to the manhole cone.

G. **Manhole Steps:** Steps **(Standard Detail C06.04)** are to be located over the outlet pipe. Steps shall be firmly anchored in the riser/cone/base sections by the precast manhole manufacturer

H. **Grade Rings/Adjustments**: In street rehabilitation work, the combination of grade rings and/or brick shall not exceed 2 rings before removal of the cone is necessary to effect adjustment. See **Standard Detail C06.03**.

I. **Replacement/Rehabilitation of Existing Manholes:**

Replacement of manholes: The Town reserves the right to require replacement of the existing manhole with a new manhole. The Town will provide the manhole but the Contractor shall pick up and install it. When a new manhole is necessary, the old manhole must be completely removed and a new precast manhole constructed in its place.

Any tie-in's performed on sanitary sewer manholes must be machine-core drilled with a neoprene flexible boot and adjustable band, except brick manholes. The core shall be the size specified with a smooth finish. If connecting to existing brick manhole, seal penetration and add "Strong-Seal" on perimeter of manhole. Coordinate with the Town.

J. **Connection to Existing Manholes**

Connection to existing sewer shall be made at manholes. For connection of encased pipe, the casing shall be flush with the inside wall and shall be encased with at least 8 inches of stone on the outside of the manhole. Existing manholes to which connections are made shall be rehabilitated, as directed by the Town Engineer, to the degree necessary to correct any apparent signs of infiltration or inflow (see paragraph 3.3 I, *Replacement/Rehabilitation of Existing Manholes*).

Upon completion of the connection to existing sewers, existing lines no longer needed shall be sealed or plugged and the invert rebuilt to reflect the new flow patterns.

K. **Testing of New Manholes**: Manholes are to be subjected to a vacuum test. Manholes shall be vacuum tested after installation in accordance with the manhole vacuum testing procedures outlined in Section 3.9, paragraph B, item 9. Service connections tied into manholes shall be tested in conjunction with the manhole.

3.4 ABANDONING SEWER LINES & MANHOLES

A. **Sewer lines**: When an existing sewer line is designated to be abandoned in place, the low end of the line is to be plugged and lean concrete grout (flowable fill) pumped into the line until it is completely filled.

B. **Manholes**: When an existing manhole, either partially or wholly, is designated to be abandoned and the sewer lines, either entering or exiting the manhole, have been abandoned according to the preceding paragraph, the upper portion of the manhole is to be removed to within 36 inches of the proposed finished grade, or as determined by the Town Engineer. Below pavement, backfill with flowable fill concrete. Outside of pavement, backfill with select fill compacted in place.

3.5 CONNECTION TO EXISTING SEWERS

Where required or shown on the plans, connection to existing sewer shall be made in a manner that will maintain existing sewage flow on a continuous basis. Where flow cannot be maintained, interruption of service shall be minimized such that no by-pass of sanitary sewage to any natural waterway or storm drain occurs nor shall such interruption create a public health hazard by sewage back up or overflows. Sewage by-pass pumping shall comply with the requirements of paragraph 3.6, *Bypass Pumping*, below.

Connection to existing sewer mains shall be made at manholes. See paragraph 3.3 J, *Connection to Existing Manholes*.

3.6 BYPASS PUMPING

A. The bypass system shall be of sufficient capacity to handle peak flow of the pipe. Provide the necessary labor and supervision to set up and operate the pumping and bypassing system. Contractor shall comply with local Town sound ordinance. If pumping is required between the hours of 8:00 PM and 6:00 AM, engines shall be equipped as specified in paragraph E, below, in order to keep noise to a minimum. The equipment shall be manned continuously. During bypass pumping operations, the Contractor shall provide the necessary labor to continually monitor the operation and ensure uninterrupted and sufficient pumping at all times.

B. Contractor shall provide all materials and labor as necessary to maintain flows in the existing sewer interceptor and all collector and lateral lines at all times and under all weather conditions. Interruption of flows will not be permitted. Overflows from bypass operations will not be permitted to enter into any streams or bodies of water. **The Contractor will be solely responsible for any legal actions taken by the state regulatory agencies if such overflows occur during construction.**

C. Bypass pumping equipment shall include pumps, conduits, engines, and related equipment necessary to divert the flow or sewage around the section in which work is to be performed. In addition, the Contactor shall maintain at the same location and in operable condition, duplicate equipment to be used in case there is equipment failure. In this event, the Contractor shall promptly repair or replace the failed equipment to the satisfaction of the Town Engineer.

D. The new sewer line may be used by the Contractor to carry the sanitary flows after the new pipe has passed inspection and testing. Any “temporary” connections to the new sewer line shall be approved by the Town.

E. Engine driven equipment for bypass pumping equipment shall have “critical grade mufflers.” If equipment is operated between the hours of 8:00 PM and 6:00 AM, this equipment shall also be provided with sound attenuation enclosure consisting of a three sided enclosure with roof constructed of 2 x 4 frame with ½-inch plywood sheathing and 2-inch Styrofoam panels attached to the inside of the entire enclosure. The enclosure shall be portable in order to allow the enclosure to be moved when bypass pumping equipment is moved. These conditions are subject to any other additional stipulations that may be required by local Town sound ordinances.

F. **Plan Requirements**: The plan should include, but is not necessarily limited to, the following details:

1) Staging areas for the pumps.
2) Sewer plug method and type of plugs or gates to be used.
3) Number, size, material, locations, and method of installation of suction piping.
4) Bypass pump sizes, capacity, number of each size to be on site, and power requirements.

5) Calculations of static lift, friction loss, and flow velocity.
6) Stand-by power.
7) Downstream discharge plan.
8) Method of noise control for each pump.
9) Temporary pipe supports and anchoring required.
10) Heavy equipment needed for installation of pumps and piping.
11) Stand-by/back-up pumpset for the bypass application.
12) Detail plan for 24-hour monitoring.
13) Fueling of pumpsets on demand.

G. **Sewer Overflows – Penalties**: The Contractor shall make every effort to avoid causing sewer overflows. All sewer overflows shall result in the following disciplinary actions:

Incident	Penalty
First Violation	$2,000
Second Violation	$5,000
Third Violation	$10,000
Fourth Violation	Termination of Contract

For all sewer overflows, the Contractor shall be responsible, and shall reimburse the Town, for any damages, operational costs, fines, or other effects.

1) **Unplanned Service Outages**: The Contractor shall make every effort to avoid causing unplanned service outages. All Contractor caused service outages shall be investigated by the Town Engineer. If the investigation determines that the Contractor could have avoided the service outage, then the outage shall result in disciplinary action as shown above.

3.7 SERVICE CONNECTIONS

A. **New Services**: Unless otherwise permitted by the Town Engineer, all sewer services shall be PVC Schedule 40 pipe solvent cement joint pipe and fittings. The laying and joining of service connection pipe shall conform to the same requirements as stipulated for main installation. Sewer services are to be connected to main except at manholes on cul-de-sacs. When connecting to manholes, services are to come in at the bottom of the manhole. See **Standard Detail 533.01**

B. **Location of Service**: Unless directed otherwise by the Town Engineer, service connections shall extend to a point within the right-of-way or easement. In streets with curb and gutter, the preferred location is 6 inches inside the right-of-way. Service connections shall not be located in driveways or the street unless the clean-out is enclosed in a cast iron box (see **Standard Detail 533.01**). The cleanout is to be set 2 inches below the bottom of the valve box cap.

C. **Bored Services**: Where laterals are bored, the face of the bore cut shall be a minimum distance of five feet from the edge of the pavement on either side unless the Town gives approval to the contrary.

D. **Service Connections**: 6-inch service connection shall be made at manholes only using core and rubber boot. 4-inch sewer laterals shall be connected to

new mains by means of an in-line monolithic wye or, if on an existing line, with a tap and saddle installed over a hole cut in the top quadrant of the main at an angle of 45degrees (see **Standard Details 533.01 and 533.02**), with respect to flow direction. The hole shall be cut with a mechanical circular type saw cutter designed for the particular use and rendering a smooth uniform cut with no damage to the main and is one that retrieves the plug. Saddle service "coupon" shall be given to the Town's Inspector for review and approval. Service saddles shall be fully encased with #57 stone and special attention shall be given to embedment of the service pipe from the saddle through the lateral trench. The cost for such cut-ins shall be included in the cost of the lateral.

Service Saddles: Service saddles shall be constructed using DFW/HPI or NDS sewer service saddles (see paragraph 2.1.2, G) placed in the top quadrant of the pipe main. Backfill under and around saddle with #57 stone. See **Standard Detail 533.02**. The cost for such cut-ins shall be included in the cost of the lateral.

A cleanout shall be installed at the terminal end of the service connection as shown on **Standard Detail 533.01**. Both the cleanout and the service material shall be capped or plugged to exclude entry of water or earth. Bronze plugs or caps shall be required for all above ground piping. All laterals are to be left exposed until the Inspectors can verify the installation of each service.

E. **Service Connection to Manholes**: Unless approved otherwise by the Town Engineer, services connections to manholes shall be made at dead end lines only. Service connections must enter the bottom of the manhole when ever possible. If not practical, services may be located above the bottom but may not enter the cone or it's joint. In this type connection, the service is to utilize an inside fiberglass drop bowl (see paragraph 2.2.14 for drop bowl spec). Drop pipes are to be securely attached to manhole walls with stainless steel pipe brackets. Service connections in manholes shall also be core bored and booted and shall be separated by a minimum of 2 times the pipe OD (either vertically or horizontally) from other services or mains. When connections are made at deep manholes, a standard drop connection shall be provided. The invert of manhole service connections shall be located such that a pipe half-diameter channel formed through the bench shall be required.

F. **Deep Sewer Service Connections**: For service connection to deep sewer with confined trenches, the service shall extend from the connection upward at a 45 degree angle to a point near the trench wall, shall bend 45 degrees up to a riser which shall parallel the vertical trench wall to a point no less than 30 inches below finished grade and shall turn using 2 consecutive 45 degree bends to provide a lateral service to match the grade and slope of the building sewer. For all other service connections, the service shall extend from the connection upward at 45 degrees to a point where it shall bend 45 degrees to match the grade and slope of the building sewer. Vertical stacks or standpipe services are not allowed.

G. **Cleanout Location**: The cleanout shall be located 6 inches inside the right of way or easement line. The cleanout is to be set 2' above final grade. See **Standard Detail 533.01**.

A cleanout box and lid shall be set over the cleanouts located in easements and within pavements.

Service connections shall not be located in driveways unless the cleanout is enclosed in a cast iron box (see **Standard Detail 533.01**) with the word "sewer" on the lid. The cleanout is to be set 2 inches below the bottom of the valve box lid. Cleanouts shall not be relocated outside of a driveway once installed.

H. **Final Cleanout Grade Adjustment**: The Plumber shall cut the riser to final grade at time of connection. A 14-inch diameter precast concrete cleanout collar, by Masonry Supply, Inc. of Selma, shall be placed set over the cleanout at finished grade. See **Standard Detail 533.01**.

I. **Cleanout Spacing:** Unless otherwise shown on the plans, cleanout spacing on either 4- or 6-inch service lines shall not exceed 75 feet on center. Cleanouts shall be provided at all horizontal or vertical changes in direction.

J. **Grade**: Minimum grade for services shall be ¼-inch per foot for 4-inch services. Minimum grade for 6-inch services are to be laid preferably at a 1/8-inch per foot, but no less than 0.6%.

K. During service installation or line rehabilitation on existing mains, the Contractor shall be responsible for the maintenance of all sewer house connections and the proper treatment and/or by-pass of effluent sewer around work areas.

L. Any services or utilities damaged by the Contractor shall be properly repaired.

M. Sewer lines shall be **air tested** (low-pressure air test) after the complete installation of all sewer services. Laterals shall be tested with the main line.

3.8 CONCRETE ENCASEMENTS

All concrete encasements shown on the plans shall be constructed per **Standard Detail C07.02**.

The earth may be used for side and bottom forms provided such sides can be excavated uniformly smooth and to the size and shape specified. Care must be taken during the pouring operation to ensure that the pipe does not float or move from the buoyant affects of the concrete. Misalignments of the crossings shall be cause for total removal and replacement of the encasement by the Contractor.

Once the concrete is set, measures shall be taken to cure the concrete by covering it with plastic. Water shall not be allowed to run over the concrete for at least 48 hours.

Forms will be required if the subgrade and sides are not firm, or will not hold shape.

Exercise care to avoid spilling concrete into creek.

3.9 TESTING

A. The following tests shall apply for the respective pipe materials as required by the following specifications.

Table 02530.3
Table of Testing Applications

Material	Air Test	Vacuum Test	Mandrel Test	TV Inspection
All PVC pipe	X		X	a
DIP	X			a
Manholes		X		

[a]On a case-by-case basis at the discretion of the Town Engineer.

B. **TEST AND INSPECTION:**

Unless otherwise specified (see paragraph 1.10.1 B2c), all sanitary sewer pipe shall be tested after backfilling has been completed and before final acceptance by the Town. Upon completion of entire pipe installation, the Town shall inspect the work in part or as a whole and make such tests as necessary to verify that the work has been carried out in accordance with the plans and specifications.

All manholes shall be of the specified size, shape, and material, and shall have their tops set to the grade as furnished by the Design Engineer.

The Contractor shall provide all equipment, material, water, labor, etc. needed to perform any and all tests in accordance with the procedures listed herein. All equipment, materials, etc. used shall be checked and approved by the Town prior to its use. It shall be the responsibility of the Contractor to ensure pipe to be tested is clean before any tests are made. Frame and covers shall be tested with manhole tests.

1) **General Requirements**: Testing and inspection shall promptly follow installation of wastewater pipe including services. Testing shall not be more than 1000 feet behind sewer pipe laying operation.

   Furnish all pumps, gauges, instruments, test equipment and personnel required for inspections and testing operations.

   All final testing and inspections shall be performed in the presence of the Town's authorized representative.

   Flush all sand, dirt and debris from lines prior to inspection. Provide lights and mirrors and inspect lines in presence of the Town's authorized representative.

   Clean and pretest prior to notifying the Town and arranging for inspections and tests.

   Inspect the system for conformance with line and grade shown on the plans and provide record drawing measurements on Record Drawings.

2) **Flushing**: If during any of the inspections sewer lines and manholes are found to contain mud and other debris, the Contractor shall be required to flush or clean this material from the system by whatever means necessary. Mud and other debris shall not be allowed to enter the existing sanitary sewer system. The Contractor shall be responsible for the cost of water used to flush the system.

3) **Backfill Testing**: Testing of backfill shall be performed in accordance with the requirements of Section 02275 – *Trenching, Backfilling, and Compaction of Utilities*.

4) **Frequency**: Test frequency shall be one test per road crossing and/or per 1000 feet of line except where additional tests are required to determine the extent of unacceptable compaction. These additional tests are the responsibility of the Contractor.

5) **Visual Inspection**: Visual inspections may be required by the Town on a case-by-case basis. When required, sewer lines shall be visually inspected from every manhole by use of mirrors and television cameras. The lines shall exhibit a fully circular pattern when viewed from one manhole to the next. Lines, which do not exhibit a true line and grade, have obstruction or structural defects, shall be corrected to meet these specifications and the sewer barrel left clean for its entire length.

6) **Pipe Deflection Test**: Deflection testing shall be performed for all semi-rigid and flexible pipe 8 inches or larger. Deflection shall not exceed 5% (95% of the ASTM base inside diameter). Testing shall be conducted in the presence of the Town's authorized representative and shall utilize a mandrel go/no-go gauge complete with proving ring. Mandrel shall be approved by the Town for this test. Arm mandrels shall have a minimum of 9 arms.

   The mandrel device shall be cylindrical in shape and constructed with a minimum of nine evenly spaced arms or prongs. Mandrels with less than nine arms will not be approved for use. The "D" mandrel dimension shall carry a tolerance of plus or minus 0.01 inch. Allowance for piping wall thickness tolerances or ovality (from heat, shipping, poor production, etc.) shall not be deducted from the "D" dimension but shall be counted in as a part of the 5% or lesser deflection allowance.

   The mandrel shall be hand pulled through by the Contractor in the presence of the Town's authorized representative. Any sections of the sewer not passing the mandrel shall be uncovered and the Contractor shall re-round or replace the sewer to the satisfaction of the Town's authorized representative. The repaired section shall be retested.

   The inspection shall be conducted no earlier than 30 days after reaching final trench backfill grade.

   Contact length shall be measured between points of contact of the mandrel arm.

   The inspector shall be responsible for approving the mandrel. Proving rings may be used to assist in this. Drawings of the mandrel with complete dimensions shall be furnished by the Contractor to the Town for each diameter and specification of pipe.

7) **Primary test method – Low Pressure Air Test**: Sewer lines shall be **air tested** after the complete installation of all sewer services. Sewer laterals are to be tested along with main. The Contractor shall be

responsible for furnishing all equipment and labor for the low pressure air test at no additional cost to the Town.

The portion of the line being tested shall be accepted if the portion under the test meets or exceeds the requirements of ASTM F1417. This requirement shall be accomplished by performing the test as follows: the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig greater than the average back pressure of any groundwater that may be over the pipe shall not be less than the time shown for the given diameters in Table I *Line Pressure Air Test Table.* If the system does not meet the foregoing requirements, the Contractor will be required to locate and repair the leaks at no cost to the Town and repeat the tests until the allowable leakage is obtained.

Procedure:

It is imperative that proper plugs be installed on the laterals at the cleanout stack. All plugs should be properly installed to withstand the test pressures without requiring external bracing or blocking. Before tests are made, all wyes, tees, or end of side sewer stubs shall be plugged with flexible-joint caps, or acceptable alternate, securely fastened to withstand the internal test pressures. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible-jointed lateral connection or extension.

Air leakage testing of installed system shall be performed with a continuous monitoring gauge no less than 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of plus or minus 0.04 psi. All air used shall pass through a single, above ground control panel visible to the Town.

All air used shall pass through a single control panel. Individual air hoses shall be used from control panel to pneumatic plugs, from control panel to sealed line for introducing low pressure air, and from sealed line to control panel for continually monitoring the air pressure rise in the sealed line. After all pipes are cleaned, air shall be slowly supplied to the plugged pipe installation until the internal air pressure reaches 4.0 psig (greater than average groundwater backpressure that may submerge the pipe). Throttle the air supply to maintain that constant pressure for at least 2 minutes. The air pressure supply shall then be disconnected from the system or shut-off. Do not enter manhole during test. Do not exceed 9.0 psig in the system.

Observe the continuous monitoring gauge while decreasing the pressure to no less than 3.5 psig (greater than groundwater pressure). At a reading of 3.5 (adjusted), or any convenient observed pressure reading between 3.5 and 4.0 psig (adjusted), timing shall commence with a stopwatch or other timing device that is at least 99.8% accurate. Regulate the pressure for at least 2 minutes to permit the air/ground temperature to reach equilibrium before commencing test.

Measure the time interval for pressure to drop 1.0 psig.

If the time, shown in Table I for the designated line size and length, elapses before the air pressure drops 1.0 psig, the section undergoing the test may be discontinued once the prescribed time has elapsed even though the 1.0-psig drop has not occurred. Record all readings.

If the pressure drops 1.0 psig before the appropriate time shown in Table I has elapsed, the air loss rate shall be considered excessive, and the section of pipe has failed the test. Record all readings.

If service lateral sewers are included in the test section, their lengths may be ignored for computing the required test times. The test will be slightly more severe. In the event a test section, having a total surface area less than 625 square feet, fails to pass the air test when lateral sewers have been ignored, the test time shall be recomputed to include all lateral.

If the sections fail the air test, the Contractor shall determine the source or sources of leakage and shall repair or replace all defective material and workmanship. No sealant shall be used in the newly installed sewers to correct the leaks.

The extent and type of repair that may be allowed shall be subject to the approval of the Town. The repaired pipe installation shall be retested and required to meet the requirements of this test.

Safety Note: The air pressure test may be dangerous if, because of ignorance or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. A force of 250 lbs is exerted on an 8-inch plug by an internal pressure of 5 psi. It should therefore be realized that sudden expulsion of a poorly installed plug, or a plug that is partially deflated before the pressure is released, can be dangerous. As a safety precaution, pressurizing equipment should include a pressure regulator set at, for example, 10 psi to avoid over-pressurizing and damaging an otherwise acceptable line. **No one shall be permitted in the manholes during testing**.

TABLE I
Line Pressure Air Test Using Low-Pressure Air
SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015
(Excerpted from ASTM F 1417)

1 Pipe Diameter (in.)	2 Minimum Time (min:sec)	3 Length For Minimum Time (ft.)	4 Time For Longer Length (sec.)	Specification 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	.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.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
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33

8) **Infiltration/Exfiltration Testing**

Infiltration/Exfiltration Testing shall be required in addition to the air test for the sewer mains if water is encountered during pipe laying conditions. Infiltration/Exfiltration shall be kept to a minimum amount as possible. All lines not conforming to these specifications shall be rejected by the Town.

Manholes shall show absolutely no evidence of leakage through the walls or bottom.

Determining Which Test to Use: If groundwater is 4 feet above top of pipe, use infiltration test. If groundwater is less than 4 feet above top of pipe, fill pipe and upstream manhole to produce a minimum 4-foot head over the top of pipe, let stand for 12 hours, refill manhole to original level, and conduct Exfiltration test for 1 hour. If the leakage exceeds the specified amount, satisfactory corrections shall be made to the sewer system. Retest as necessary until all tests are returned satisfactory.

Infiltration Test: No infiltration tests will be made until normal infiltration conditions are established. Test shall be made before connections are made to existing sewers and shall be measured by means of a V-notch weir inserted into the line at a manhole of built in a manhole. Tests will not be allowed until all service lines are installed. These tests will determine the correct rates of ground water infiltration. Weir measurements shall be taken at points designated by the Town along the completed pipelines, and at least one measurement shall be made for each 5,000 LF of pipe. Tests shall be made in the presence of the Town's authorized representative. When infiltration occurs in excess of the specified amounts, defective pipe or joints shall be located and repaired. If the defective portions cannot be so located, the original work shall be removed and reconstructed as necessary to obtain a sewer within the allowable infiltration limits upon retesting.

Exfiltration Test: Where lines are above the groundwater table, exfiltration testing will be required. Also, for lines that may be seasonally below the groundwater table or flood levels, but due to dry conditions, upon completion of construction under normal infiltration conditions are not present, the exfiltration tests may be conducted in lieu of infiltration tests.

Infiltration/Exfiltration Limits: Infiltration shall be measured by the Contractor in the presence of the Town Engineer or his representative and shall not exceed 50 gallons per inch diameter per mile per day for pipe diameter larger than 18 inches. For exposed or aerial piping and pipe diameters 18 inches and smaller, there shall be no visible signs of infiltration. Infiltration and exfiltration testing of the lines in lieu of air testing **shall not be accepted** without written approval of the Town Engineer. For these methods to be considered, the Contractor shall state, **in writing**, the reasons for this consideration.

9) **Manhole Vacuum Testing**

Manholes shall be vacuum tested as indicated below unless otherwise allowed by the Town. Vacuum testing shall meet ASTM C1244 *Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test.* Only new manholes are to be vacuum tested. Vacuum testing of existing manholes is not required.

The test shall be made using an inflatable compression band, vacuum pump, and appurtenances specifically designed for vacuum testing manholes. Equipment to be manufactured by Peter A Glazier & Associates, Worcester, MA or approved equal. The Contractor shall be responsible for furnishing all equipment and labor for the vacuum test at no additional cost to the Town.

Manholes may be tested by vacuum test immediately after assembly of the manhole, frames and connecting pipes, and before any backfill is placed around the manholes. However, the final test and acceptance shall be based only upon a test after the manhole is backfilled and the cover frame castings are grouted in place. Testing devices shall be installed on the iron manhole frame.

All lift holes shall be plugged with nonshrink grout and all pipes shall be plugged, taking care to securely brace the plugs and pipe. Stubouts, manhole boots, and pipe plugs shall be secured to prevent movement while the vacuum is drawn.

Manholes shall be tested from the top of the casting, including the casting-to-cone joint (adjusting ring).

Installation and operation of vacuum equipment and indicating devices shall be in accordance with manufacturer's recommendations.

After the testing equipment is in place, a measured vacuum of 10 inches of mercury (Hg) shall be established in the manhole. The time for the vacuum to drop to 9 inches of mercury shall be recorded.

Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from 10 inches to 9 inches of mercury. See Table II, *Vacuum Test Table for Manholes*.

If the manhole fails the test, the Contractor shall locate the leakage, make the proper repairs, and the vacuum test shall be repeated until the manhole passes the test. After the manholes have been backfilled and the cover frame casting sealed in place, and prior to final acceptance of the project, any signs of leaks or weeping visible from the inside of the manhole shall be repaired and the manhole made watertight and tested. The extent and type of repairs that may be allowed shall be subject to the approval of the Town. Leaks shall be repaired on the outside of the manhole unless approved otherwise by the Town.

If a manhole joint mastic material is completely pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced.

10) **Televising of Sanitary Sewers**

TV inspections may be required by the Town on a case-by-case basis. When required, following placement and compaction of backfill and completion of other required testing, but prior to placing of pavement, the Contractor shall televise all sewer lines for conformance to the project drawings and specifications. The sewer main shall be cleaned prior to the TV inspection. A tape and log of the televising shall be delivered to the Town within a week of televising. If defective pipe or conditions are discovered they shall be corrected at no cost to the Town.

The television camera used for the inspection shall be one specifically designed and constructed for such inspection. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe. The camera shall be operative in 100% humidity conditions. The camera, television monitor, and other components of the video system shall be capable of producing picture quality to the satisfaction of the Town; and if unsatisfactory, equipment shall be removed and no payment will be made for an unsatisfactory inspection.

The camera shall be moved through the line in either direction at a moderate rate, stopping when necessary to permit proper documentation of the sewer's condition. In no case will the television camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions shall be used to move the camera through the sewer line. If, during the inspection operation, the television camera will not pass through the entire manhole section, the Contractor shall set up his equipment so that the inspection can be performed from the opposite manhole. If, again, the camera fails to pass through the entire manhole section, the inspection shall be considered complete and no additional inspection will be required.

The Town may also televise sewer lines prior to the expiration of the one-year warranty. If a defective condition is found, it shall be presumed to be caused by defective workmanship or materials. The Contractor shall be notified and shall correct the work in a manner approved by the Town.

11) **Force mains**

a. **Order of Operations**: Except for chlorination and tests for purity, the installation of sewer force mains shall be set forth on the plans and shall meet the requirements for water mains and as set forth in these specifications. Fill the system with water at a velocity of approximately 1 foot per second while necessary measures are taken to eliminate all air. Do not leave fill line connected to sewer line unless an RPZ backflow preventer is placed between the potable water supply and the line being filled.

b. **Pressure Tests & Leakage**: The Contractor shall test completed sections of line, including fittings, with water. This testing, however,

does not relieve the Contractor of his responsibility to repair or replace any cracked or defective pipe. All work necessary to secure a tight line shall be performed by the Contractor. Testing shall be performed in the presence of the Town's authorized representative and the Contractor. Cost for testing shall be incidental to line construction. Final acceptance from the Town shall be contingent upon all pressure and leakage tests yielding satisfactory results.

Pressure Test: The newly laid piping or any valved section of piping shall, unless otherwise specified, be subjected for two hours to a leakage test. Raise the pressure by pump to 150 psi, 150% of design working pressure, or test pressure as shown on the drawings, whichever is greater. Measure the pressure at the low point on the system compensating for gauge elevation. Maintain this pressure (+ or – 5psi) for 2 hours. If pressure cannot be maintained using reasonable pumping rate, determine cause, repair, and repeat the test until successful. The allowable leakage shall be no greater than allowances shown in Table 6A - Hydrostatic Testing, Section 5.2, of AWWA C 600-93, *AWWA Standard for Installation of Ductile Iron Water Mains and Their Appurtenances*. A copy of this chart is located at the rear of the Town of Clayton specification Section 02510 *– Water Distribution*. Contractor shall be responsible for all costs, labor, materials, and equipment to perform the testing. All visible leaks, broken or cracked pipe, valves, etc. shall be repaired.

i. Prerequisite conditions for testing shall be as follows:

- All pipe has been laid and the trench backfilled.
- Valves shall be properly located, operable and at correct elevation.
- All reaction anchors have had sufficient set of 3 days. High early strength concrete, 4500 psi or greater, may be used to reduce number of days.
- Lines shall be properly vented where entrapped air is a consideration.
- All construction activities on the project, that requires trenching or excavation within the limits of the line location, shall be completed prior to pressure testing of line.

3.10 PUMP STATIONS AND FORCE MAINS

A. **General:**

Pumps shall be submersible grinder pumps with electro-mechanical controls. Pumps shall be designed for continuous duty pumping raw, unscreened wastewater.

Submersible Pumps: Pumps shall be submersible pumps with electro-mechanical controls. Pumps shall be designed for continuous duty pumping raw,

unscreened wastewater. Pumps shall be capable of handling a 3-inch solid and any trash or stringy material that can pass through a 4-inch hose unless mechanical means of solids reduction is installed at the pump. Pumps shall be made non-clog by either passing solids, trash, and stringy material through a non-clog or vortex-type impeller or by grinding, chopping, or cutting them prior to passing them through the impeller. Impellers shall have blades that are generally forward rounded or otherwise configured to avoid catching solids, trash, and stringy material. **Standard Detail 534.02** for typical wetwell and valve vault arrangement.

Station Layout: See **Standard Detail 534.08** for typical pump station site layout.

Lift stations, at a minimum, shall include the following:

1) Inspection and Testing: See paragraph 3.9.B.9 Manhole Vacuum Testing, for manhole testing requirements.
2) Service head, meter base, service connection, disconnect, and area light with switch.
3) Audible and visual high water alarm and alarm silence.
4) Autodialer (minimum 8 numbers, 8 channels): Autodialer shall be RACO Verbatim telephone autodialer. The automatic telephone dialer shall be a solid-state component capable of dialing up to 8 phone numbers, each up to 24 digits in length. The dialer shall have solid-state voice message recording and playback, all implemented with permanent nonvolatile solid-state circuitry with no mechanical tape mechanism. The auto-dialer shall be programmed to alarm to dialer when the generator either starts or fails. As an alternate, SCADA System may be required on a case-by-case basis by the Town Engineer and reviewed for compatibility with the Town of Clayton system.
5) Automatic air release valves, as applicable.
6) Primary level control shall be ultrasonic with hand-off-automatic (H-O-A) switches and an automatic alternator.
7) Provide mercury float switch type control system as secondary level control with hand-off-automatic (H-O-A) switches and an automatic alternator.
8) Independent high water alarm circuitry.
9) 3-phase voltage monitor, if applicable. Indication of 3-phase power fail.
10) Discharge gauges.
11) Elapsed time indicators.
12) High pump temperature protection.
13) Pump run lights.
14) Motor overload resetter
15) TLVSS Surge suppressor by Seimens
16) Duplex service receptacles on GFCI.
17) Surge relief valve and return piping to wetwell.
18) Dual power supply auto switchover, etc.
19) Non-Freeze Flush Hydrant (Eclipse No. 2 post hydrant as manufactured by John C. Kupferle Foundry Company, St. Louis, MO). See **Standard Detail 514.08**.
20) Cold-weather ballast fluorescent lighting suitable for exterior use under rain hood.

21) Provide condensate heater on thermostat inside pump control panel.
22) The lift station is to include back-up alarm system that operates off a 12-volt battery connection in the event of power failure. The battery system is to include a trickle charger to ensure battery integrity.
23) Station Start-up assistance and certification: Station start-up and certification shall include an operational/witness/drawdown test.
24) Control Panel Dead Front: Panels on the primary pump station, backup pumps or generators shall comply with NFPA 70E. The following elements, when applicable for the type system under consideration, at a minimum, shall be accessible and located in front of the dead front panel and/or barriers installed to make the following accessible without being exposed to live conductors: Control/programming keyboards, all hand operated switches, H-O-A switches, disconnects, pump run lights and run time gauges, alarm silence, duplex receptacles, motor overload resetter, gauges (such as ammeter, temperature, fuel level indicator), indication of 3-phase power fail, handles, GFCI switch (on/off), circuit breakers, area light, autodialer, etc.
25) Backup Systems: The designer must provide backup service by a Dri-Prime backup pump. A backup generator can be substituted at the discretion of the Town Engineer. If a backup generator is provided, provide 1 spare pump/motor. The minimum design criteria for each option are outlined below.
26) Provide programmable auto-exercise cycle for both backup pump and generator.

DRI-PRIME BACK-UP PUMP OPTION

Provide auxiliary diesel fired automatically activated stand-by dri-prime back-up pump with automatic reset, placed on site. Pump manufacturer to provide power demand/ratings to Contractor before ordering pump and the power demand appropriately marked on the pump shop drawings. The Contractor shall provide a complete engine driven back-up pump. The back-up pump set shall consist of four-cycle, radiator-cooled, engine direct connected to pump, a unit-mounted control panel, unit-mounted fuel tank, all mounted on a common sub-base. Starting shall be from batteries, with capability to start the unit at 32 degrees temperature. The control panel shall be complete with engine controls and instruments, safety controls and panel lights and include, but not necessarily limited to, the following:

a. Permanent skid mounted trash pump for pumping raw sewage.
b. Pump shall be fitted with a fully automatic priming system capable of repeated priming from a completely dry pump casing.
c. The pump offered shall be the manufacturer's standard production model.
d. Maximum solids handling size: 3 inches
e. Maximum duty point shall meet the suction, head, and flow requirements of the station at which the pump will be located.
f. Priming System: Automatic priming system incorporates a twin-cylinder compressor and air ejector assembly, no vacuum pump. The compressor shall be installed on the engine auxiliary drive and shall be gear driven, lubricated, and cooled from the engine. The priming system shall require no fail-safe protection float gear or any adjusting at high or low suction lifts. Pumps with self-priming chambers modified with

vacuum priming systems shall not be accepted as equal. The pump must be capable of running totally dry for periods up to 24 hours, then re-priming and returning to normal pumping volumes. Pump and priming system is capable of priming the pump from a completely dry pump casing. The pump shall be capable of static suction lifts consistent with the site requirements, at sea level. It shall also be capable of operation using extended suction lines. Equipment acceptance shall be contingent upon the pump's ability to run continuously at full speed in a completely dry condition for periods up to 24 hours. The Town's engineer may require a demonstration.

g. Check Valve Pump shall be supplied with an integral swing type check valve mounted on the discharge of the pump allowing unrestricted flow from the impeller. The check valve shall prevent in-line return of flow when the pump is shut off.
h. Drive Unit: The drive unit shall be a diesel water-cooled engine. The engine shall drive the pump by use of direct connected intermediate drive plate. Starter shall be 12 volt electric. Safety shut down switches for low oil pressure and high temperature shall be integral to the engine control panel. Battery shall have 180-amp hour rating. The engine control panel shall include a tachometer and an hour meter. A certified continuous duty engine curve shall be supplied to the owner/engineer.
i. Engine Control Panel: Engine speed shall be adjustable to operate the pump between maximum and minimum design operation speeds in manual mode.
j. Skid Base/Fuel Tank: Integral structural steel skid type fuel tank shall be sized with sufficient capacity to provide at least 24 hours of operating time at full load. The engine shall be capable of operating satisfactorily on a commercial grade of distilled No. 2 fuel oil.
k. Exhaust: Exhaust system shall include a stainless steel critical grade muffler of suitable size. Exhaust system shall have muffler and exhaust tubing sized to match maximum engine exhaust flow without exceeding engine manufacture's maximum allowable back pressure values.
l. Sound Attenuated Enclosure: The engine and pump shall be completely enclosed with acoustical sound deadening material. The acoustical enclosure shall reduce pump and engine noise to 68 dBA or less at a distance of 30 feet. The panels shall be removable for easy access to the engine / pump for maintenance and repair. The engine control panel shall have a locking door for visual inspection. For maintenance and service needs, the pump discharge side of the unit shall have a hinged door for quick access to the engine oil fill, fuel fill port, oil dipstick and filters.
m. Automatic Starting Control System: The engine shall be equipped with a factory installed microprocessor-based controller and designed to start/stop the engine at a signal supplied by high and low level floats.
n. Engine/Pump Control Specifications: The engine shall be started, stopped, and controlled by a high performance state of the art digital controller. The controller shall be minimum NEMA 3R weatherproof enclosed, and contain an external weatherproof 12-position keypad accessible without the need to remove or open any protective cover or enclosure. It shall be designed to start/stop the engine at a signal supplied by high and low level floats. The pump controls shall provide the following minimum functions without modification, factory recalibration or change of chips or boards by simply accessing the keypad.

i The keypad shall be a capacitive touch sensing system. No mechanical switches will be acceptable. The keypad shall operate in extreme temperatures, through ice, snow, mud, grease, etc. and maintain complete weather tight sealing of the panel.
ii In automatic mode, the unit shall conserve energy and go to "sleep."
iii The panel shall function as manual start/stop by selection at the keypad. No other equipment or hardware changes are required.
iv The panel shall be capable of varying the engine speed to maintain a constant level in a process without a change to the panel other than via the keypad.
v The start function can be programmed to provide 3 separate functions each day for 7 days (i.e. a start, warm up, exercise cycle on two separate days at different times and for a varying length of time all via the keypad).
vi Manual-Automatic Button: In Manual Mode, Manual "Start" button starts engine and runs until "Stop" button is depressed or an emergency shutdown occurs.
vii The controller shall integrate the engine safety shut-off for low-oil temperature, high-temperature, and provide over-speed protection.
viii The controller shall include standard field adjustable parameters for engine cycle crank timer, shutdown time delay, warm-up time delay, and cool-down time delay.
ix The panel shall have only one circuit board with 8 built in relays. Each relay can be named to provide any function all via the key pad without changing relays, chips, printed circuits or any hardware or software.
x Circuit breakers shall be provided with a built in control panel. Provide fuses or circuit breakers for battery charger and engine.
xi Standard components shall consist of (24) digital inputs, (7) analog inputs, (1) magnetic pick-up input, (8) 20-amp form "C" relays, (1) RS232 port, (1) RS485 port, (1) RS232/RS485 port, (1) J1939 port, and (1) 64X128 pixel full graphic LCD display with backlight.
xii The industrially panel shall withstand vibration of 3 g, 3 axis, frequency swept 10-1000 Hz, in an operating temperature range of 4°F to 176°F and an operating humidity range of 0-95% Non-Condensing.
xiii The control panel shall comply with NFPA 70E and shall be complete with run-stop-remote switch; remote start-stop terminals; cranking limit; battery charge rate ammeter, oil pressure gauge, temperature gauge; low oil pressure shutdown; high engine temperature shutdown; over speed shutdown; and running time meter, all gauges located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors.

o. The back-up pump unit shall be capable of shutting down and activating the audible and visual alarms and telemetry if a damaging operating condition develops.
p. Provide manufacturer's recommended anti-freeze, engine heaters, and suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
q. Light: The unit shall include a single switch operated 12 VDC light within the enclosure.

r. Floats: The unit shall be supplied with 1 float assembly including 2 normally open (N/O) floats which shall integrate with the engine control panel via a single multi-pin plug. Bypass pump “on” float to be placed above the high water alarm.
s. The manufacturer of the unit shall completely assemble and test the unit before shipment. He shall be one who is regularly engaged in the production of such equipment, and who has spare parts and service facilities. He must also provide one complete set of filters.
t. The controls must indicate engine run, common engine fail, transfer switch position, low fuel level, and fuel tank leak for remote telemetry purposes; all gauges located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors.
u. The backup pump shall be equipped with an automatic transfer switch to start pump and transfer operation to emergency operation in case of utility under voltage, over voltage, power loss, phase reversal, or phase loss. Response time on transfer switch, due to loss of utility power, needs to be adjustable by owner.
v. All accessories needed for the proper installation of the system shall be furnished. Included should be batteries, battery cables, exhaust piping, mufflers, vibration mounting, and three bound sets of detailed operation and maintenance manuals with parts list. Batteries should be lead acid.
w. Operation and Maintenance instructions. The Contractor shall provide a minimum of four continuous hours of operation and maintenance instructions for the Owner’s personnel.
x. The Town must be furnished with one complete set of air, oil and fuel filters.
y. Provide 5-year warranty from manufacturer of Pump and Engine.

BACKUP GENERATOR OPTION

Provide auxiliary natural gas, LP gas, or diesel fired automatically activated stand-by power generator source with automatic reset, placed on site. Pump manufacturer to provide power demand/ratings to Contractor before ordering pump and the power demand appropriately marked on the pump shop drawings. Generator shall have the capacity sufficient to sequentially start and run all pumps in the pump station. The Contractor shall provide a complete engine driven generator set. The generator set shall consist of four-cycle, radiator-cooled, engine direct connected to an alternating current generator, a unit-mounted control panel, all mounted on a common sub-base. The control panel shall be complete with engine controls and instruments, safety controls and panel lights and include, but not necessarily limited to, the following:

a. The generation unit shall be capable of powering the pump motors starting current, electrical systems, instrumentation/controls and alarm systems, and other auxiliary equipment as may be necessary to provide for the safe and effective operation of the pump station. The generation unit shall have the appropriate power rating to start and continuously operate under all connected loads.
b. The generation unit shall be provided with special sequencing controls to delay lead and lag pump starts unless the generating unit has the capacity to start all pumps simultaneously while the auxiliary equipment is operating.

c. The generation unit shall be capable of shutting down and activating the audible and visual alarms and telemetry if a damaging operating condition develops.
d. The generation unit shall be protected from damage when restoration of power supply occurs.
e. The generator shall be equipped with an automatic transfer switch to start generator and transfer load to emergency in case of utility under voltage, over voltage, power loss, phase reversal, or phase loss. Response time on transfer switch, due to loss of utility power, needs to be adjustable by owner.
f. The control panel shall be complete with run-stop-remote switch; remote start-stop terminals; cranking limit; battery charge rate ammeter, oil pressure gauge, temperature gauge; low oil pressure shutdown; high engine temperature shutdown; over speed shutdown; AC voltmeter; voltage adjustment; frequency meter; and running time meter. Switches and gauges shall be located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors and shall comply with NFPA 70E.
g. Circuit breakers shall be provided with a built in control panel.
h. Provide manufacturer's recommended anti-freeze, engine heaters, and suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
i. The manufacturer of the unit shall completely assemble and test the unit before shipment. He shall be one who is regularly engaged in the production of such equipment, and who has spare parts and service facilities. He must also provide one complete set of filters.
j. The controls must indicate engine run, common engine fail, transfer switch position, low fuel level, and fuel tank leak for remote telemetry purposes. Lights and gauges must be located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors and shall comply with NFPA 70E.
k. The automatic transfer switches must have a disconnect on the utility service main side.
l. The generator shall comply with the following minimum requirements:
    i Engine: Four-cycle, 4 cylinder, radiator cooled, at 1800 RPM. Starting shall be from batteries, with capability to start the unit at 32 degrees temperature.
    ii Generator: Rating shall be continuous standby service at 0.8 power factor, at 1800 RPM.
    iii Voltage: Three-phase. KW rating to match facility needs.
    iv Engine shall be equipped with an isochronous governor as manufactured by Woodall.
    v Frequency regulation shall be less than 3-cycles from no-load to full load.
m. All accessories needed for the proper installation of the system shall be furnished. Included should be batteries, battery cables, exhaust piping, mufflers, vibration mounting, and three bound sets of detailed operation and maintenance manuals with parts list. Batteries should be lead acid.
n. The generator set shall be enclosed with a factory-installed weather-protective housing (sound abating enclosure to 68db @ 23 ft.) Housing shall provide easy access to the engine-generator and instrument panel. Muffler to be designed so exhaust is not blown or sucked across the set by cooling air.

o. Included with the generator shall be a complete fuel system consisting of a fuel tank, fuel gauge, fuel lines, fuel pumps (if applicable), valves and any and all other items incidental to a first-quality installation.
p. Diesel Option: Provide integral sub-base double-walled diesel tank. The tank is to be UL approved closed-top dike type. The tank shall also be fitted with a leak sensor device. The tank must have a capacity to run the generator for a minimum of 24 hours at 100% load.
Tank shall consist of the fuel tank separate and contained within the frame. No generator weight is to be supported by the tank. Provide a drain plug at one end of the rupture basin. Provide vibration isolators between generator set and tank assembly. Provide fuel low-level alarm remote mounted.
q. LP Option: The tank must have a capacity to run the generator for a minimum of 24 hours at 100% load.
r. Provide manufacturer's recommended anti-freeze and engine block heater, per manufacturer's recommendations, with thermostatic controls to maintain engine coolant at proper temperature to fulfill start-up requirements, adjustable if possible. Provide suitable trickle battery charger. All accessories shall be engine-mounted and within the weatherproof sound attenuated housing.
s. Provide annunciator panels with visual and audible alarms to monitor and warn of emergency operation conditions affecting line and generator power sources.
t. Provide stainless steel super critical grade type exhaust silencer mounted inside of the generator enclosure for corrosion protection.
u. Provide amp meter, voltmeter, and frequency meters with phase switches. Meter gauges shall be located in front of the dead front and/or barriers to make them accessible without being exposed to live conductors and shall comply with NFPA 70E.
v. Provide fuses or circuit breakers for battery charger and engine.
w. Provide an automatic battery charger, static type, magnetic amplifier control with DC voltmeter, DC ammeter and potentiometer for voltage adjustment. The charger is to be completely automatic and rated for the type of battery use. The charging rate is to be determined by the state of the battery and reducing to milliamp current on fully charged battery. The charger shall be 120 V., single-phase, 60 cycle, AC input with 6-amp maximum output.
x. Operation and Maintenance instructions. The Contractor shall provide a minimum of four continuous hours of operation and maintenance instructions for the Owner's personnel.
y. The Town must be furnished with one complete set of air, oil and fuel filters.
z. Provide 5-year warranty from manufacturer of Generator and Engine.
aa. Provide three bound (3-ring binder) sets of Operation and Maintenance Manual for all components relative to lift station generator.

B. **Pump Certification**: Manufacturer's representative shall be present at pump start-up. See paragraph I, *Pump Station Operational/Witness Test/Start-up* requirements, below.

C. **Wetwell Coating**: Wetwell interiors shall be coated with a two component elastomeric, hydrophobic, corrosion resistant polyurea coating where the primer can be applied to damp or dry surfaces. Primer coat film thickness shall be 1.5

to 3 mils. The top coat film range shall be from 8 to 12 mils. Shore hardness D shall be minimum 75. Coating shall equal or exceed Duramer K-2002 by Innovative Polymer Solutions, LLC. Contractor to follow all applicable safety measures for handling and application as recommended by the Manufacturer of the coating. Comply with applicable confined space safety requirements.

D. **Wetwell/Valve Vault Hatches**: Provide access frames and covers meeting Section 2.2.21 of this specification with padlocked hasps.

E. **Force mains**: 4-inch and larger force mains shall be ductile iron, PVC C900 or HDPE (4-inch through 8-inch). For 2-inch and smaller force mains, comply with ASTM D2241 per paragraph 2.1.2.D. For HDPE force mains, pipe shall comply with paragraph 2.1.2 E. Other PVC force mains must be approved by the Town Engineer.

Pipe joints shall be push on or mechanical joint type. Fittings shall be mechanical joint with appropriate blocking and/or rodding. Force mains shall be constructed in accordance with the plans and in accordance with the requirements applicable to water main construction.

F. **Connection of Force Mains to Existing Manholes – Manhole Corrosion Protection**: To protect the manholes (cementitious materials and metals) from Hydrogen Sulfide (H_2S) and Sulfuric Acid (H_2SO_4) corrosion, the Town Engineer may require the Contractor to line the manhole at the force main connection as well as the next 2 to 4 manholes downstream of the force main connection.

G. **Manuals/Parts**: The Town must be furnished with 3 copies of the Operation and Maintenance and Parts Manuals for the pumps/motors and/or station, pump controls, the generator unit, and the automatic transfer switch. Also, provide a spare impeller, key, nut, washer, and mechanical seal for each pump.

H. **Safety Placards**: Provide safety placards as required for structure (e.g. confined access entry) and equipment as required by OSHA shall be posted and readily visible.

I. **Pump Station Operation/Witness Test/Start-up:**

1) **Witnessed Testing**: Witnessed testing shall be performed in the presence of the Town's authorized representative and the results of the testing maintained as part of the construction record documentation. Witnessed testing shall include start-up assistance by a qualified factory representative and certification. Prior to acceptance by the Town, an operational test of all pumps, drive, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

After construction debris and foreign material has been removed from the wetwell, the Contractor shall supply an adequate amount of clear water volume to operate station through several pumping cycles. Observe and

record operation of pumps, suction (if applicable) and discharge gage readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems. Be alert to any undue noise, vibration, or other operational problems.

2) **Drawdown test**: The Contractor shall conduct a drawdown test to confirm that the pump is operating at or near the required design operating point and to determine the actual pumping rate of each pump. This test shall be conducted in the presence of the Town's authorized representative, the Contractor and a representative of the pump manufacturer. The rate shall be determined by subtracting the starting static surface elevation of the water in the wetwell from the "off" elevation and multiplying the difference by the volume per vertical foot of wetwell. That number shall then be divided by the number of minutes of pump run time to affect the drop measured. This test shall be performed for each pump and the rates recorded for each pump and included as part of the record in the certified pump test.

3) **Manufacturers Start-up Services**: The manufacture's representative shall be present at pump start up. Co-ordinate station start-up with manufacturer's technical representative. The representative or factory service technician shall inspect the completed installation. He shall calibrate and adjust instrumentation, correct or supervise correction of defects or malfunctions, and instruct operating personnel in proper operation and maintenance procedures.

3.11 PIPE DESIGN LIFE

In addition to the above noted specifications, the Contractor shall secure and the manufacturer shall furnish and warrant that sanitary sewer pipe is designed for a 50-year life.

3.12 CLEANUP AND RESTORATION OF SITE

After the backfill is completed, the contractor shall dispose of all surplus material, dirt and rubbish from the site, and shall keep the site free of mud and dust to the satisfaction of the Town. The Contractor may be required to flush or sprinkle the street to prevent dust nuisance. It is important that clean up and restoration of the site follows the work closely. The Contractor shall dispose of surplus material and clean the street at the end of each day for the portion of work completed that day unless additional cleaning is required. After all work is completed, the Contractor shall remove all tools and other equipment, leaving the site free, clean, and in good condition.

TABLE II VACUUM TEST TABLE FOR MANHOLES BASED ON ASTM C1244					
MINIMUM TEST TIMES FOR VARIOUS manhole DIAMETERS FOR PRESSURE DROP FROM 10 INCHES TO 9 INCHES HG.					
	DIAMETER (FEET)				
Depth (FT)	4	4.5	5	5.5	6
	TIME (SECONDS)				
6	15				
8	20	23	26	29	33
10	25	29	33	36	41
12	30	35	39	43	49
14	35	41	46	51	57
16	40	46	52	58	67
18	45	52	59	65	73
20	50	53	65	72	81
22	55	64	72	79	89
24	59	64	78	87	97
26	64	75	85	94	105
28	69	81	91	101	113
30	74	87	98	108	121

END OF SECTION 02530

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