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## SECTION 1A

### SANITARY SEWER SYSTEM - GRAVITY

#### PART 1 GENERAL

##### 1.01 SECTION INCLUDES

- A. Work under this section includes, but is not limited to piping, valves, and appurtenances for a complete sanitary sewer collection system associated primarily with gravity sewer.

##### 1.02 DESIGN CRITERIA AND PERMITTING

- A. The design of all public sanitary sewer systems that are to become a part of the City of Clinton's wastewater collection system, shall be in accordance with the N.C. Department of Environmental Quality's publications "Minimum Design Criteria for the Permitting of Gravity Sewers" and "Minimum Design Criteria for the Permitting of Pump Stations and Force Mains" and the requirements contained herein.
- B. Engineer/Developer shall prepare and submit all applicable permit applications required by federal, state and local authority. All fees are the responsibility of the Developer.
- C. Sanitary sewers shall be installed in street rights-of-way or permanent easements. Minimum easement widths shall be as follows:
  - 1. Depth of Sewer  $\leq$  8'; ..... 20 feet
  - 2. 8' < Depth of Sewer  $\leq$  12'; ..... 30 feet
  - 3. 12' < Depth of Sewer  $\leq$  14'; ..... 40 feet
  - 4. Depth of Sewer > 14'; ..... To Be Determined by City

##### 1.03 REFERENCES

- A. Publications are referred to in the text by basic designation only.
  - 1. American Society for Testing and Materials (ASTM)
    - a. A48 Gray Iron Castings
    - b. A126 Gray Iron Castings and Valves, Flanges and Pipe Fittings
    - c. A536 Ductile Iron Castings
    - d. C478 Precast Reinforced Concrete Manhole Sections
    - e. C890 Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
    - f. C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
    - g. C990 Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Performed Flexible Joint Sealants
    - h. C1244 Test Method for Concrete Sewer Manholes by the Negative Air Pressure

- i. D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>))
  - j. D1248 Polyethylene Plastics Molding and Extrusion Materials
  - k. D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
  - l. D1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
  - m. D1785 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 & 120
  - n. D2241 Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)
  - o. D2321 Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe
  - p. D3034 Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
  - q. D3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
  - r. F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe
  - s. F794 Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
2. American Water Works Association (AWWA)
- a. C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
  - b. C110 Ductile-Iron and Gray-Iron Fittings, 3 inch through 48 inch, for Water and Other Liquids
  - c. C115 Flanged Ductile-Iron Pipe with Threaded Flanges
  - d. C151 Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
  - e. C153 Ductile-Iron Compact Fittings, 3 inch through 16 inch, for Water and Other Liquids
  - f. C504 Rubber Seated Butterfly Valves
  - g. C507 Ball Valves, 6 inch through 48 inch
  - h. C508 Swing-Check Valves for Waterworks Service, 2 inch Through 24 inch NPS
  - i. C509 Resilient-Seated Gate Valves for Water Supply Service
  - j. C512 Air-Release, Air / Vacuum, and Combination Air Valves for Waterworks Service
  - k. C515 Reduced Wall, Resilient-Seated Gate Valves for Water Supply Services
  - l. C550 Protective Epoxy Interior Coatings for Valves and Hydrants
  - m. C600 Standard for Installation of Ductile Iron Water Mains and Their Appurtenances
  - n. C605 Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
  - o. C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inch through 12 inch, for Water Distribution

- p. M23 PVC Pipe - Design Installation
- 3. National Sanitation Foundation (NSF) Standards
  - a. 14 Plastic Piping Components and Related Materials
- 4. UNI-BELL Plastic Pipe Association (UNI)
  - a. B-5 Recommended Practice for the Installation of Polyvinyl Chloride (PVC) Sewer Pipe
  - b. B-6 Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe

#### **1.04 SUBMITTALS**

- A. Submit the following to the City's Public Works and Utilities Department prior to beginning work:
  - 1. All related Design Calculations, sealed as required by a Professional Engineer licensed to practice in North Carolina.
  - 2. Affidavit of Compliance: Affidavit shall attest that supplied products conform to the referenced standard and this specification and that tests set forth in each applicable referenced publication have been performed and that test requirements have been met. Affidavits shall be provided for all pipe, ductile iron pipe liner, valves, pre-cast structures, pumps, generators, switch gears and other items as requested by the City.
  - 3. Catalog Data: Submit manufacturer's standard drawings or catalog cuts for all pipe, ductile iron pipe liner, valves, pre-cast structures, (including steps, pipe connectors, joint materials, castings) service saddles, and other items as requested by the City.
  - 4. Manufacturer's Installation Procedures.
  - 5. Prior to final acceptance, submit test reports, in booklet format, including but not necessarily limited to the following:
    - a. Field Test report for each section of pipe installed including:
      - 1) Low pressure air test for gravity mains.
      - 2) Vacuum test for manholes or other pre-cast structure
  - 6. Permits: Submit copies of all required and applicable for the proposed project.

#### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. All materials and equipment shall be handled and stored in accordance with the manufacturer's recommendations.

#### **1.06 QUALITY ASSURANCE**

- A. All parts and materials incorporated into a project shall be new and unused.
- B. Contractors must be licensed by the N.C. Licensing Board for General Contractors and have a classification and a cost limitation appropriate for the work to be performed.

## **1.07 WARRANTY/SERVICE AGREEMENT**

### **A. Line Work**

1. All materials and workmanship shall have a one-year warranty from the date of final acceptance by the City. A warranty inspection will be made jointly by the City and Contractor/Developer/Engineer approximately eleven (11) months after initial acceptance to identify needed repairs. All labor, equipment and materials needed to make these repairs shall be the responsibility of the Contractor.

## **PART 2 ALLOWABLE PRODUCTS AND MATERIALS**

### **2.01 PIPE AND ACCESSORIES**

#### **A. Ductile Iron Pipe for Gravity Sewer and Force Main**

##### **1. General**

- a. Ductile Iron Pipe (DIP) shall meet the requirements of AWWA C-151 and as required herein.
- b. Ductile Iron Sewer Pipe must be easily recognized by brownish red bells and spigots, as well as, exterior stenciling of the words "For Sewer Only".

##### **2. Thickness Class**

- a. Pipe thickness class shall be determined by pipe diameter, system working pressure and anticipated laying conditions. In general, for a 12-inch or less diameter pipe with a burial depth of 15 feet or less in a Type 2 laying condition, the pipe pressure class will be Class 350.

##### **3. Pipe Lining**

- a. When used in sanitary sewer applications, ductile iron pipe and fittings shall be lined with 40 mils of Protecto 401 Ceramic Epoxy liner or equal. All bells and spigots shall be lined with a minimum of 8 mils of Protecto 401 or approved equal.
- b. The liner shall meet the manufacturer's recommendations.

##### **4. Joints**

- a. Ductile iron pipe for below ground service shall have push-on or mechanical joints, unless otherwise required by the City and shall conform to AWWA C151.
- b. Ductile iron pipe for above ground service shall have flanged joints unless otherwise required by the City and shall conform to AWWA C115.
- c. Ductile iron pipe on piers shall have rigid restrained joints as recommended by the pipe manufacturer.

##### **5. Restrained Joints**

- a. Provide restrained joint pipe at fittings and valves as calculated by the Design Engineer and approved by the City.. Restrained joints shall be Snap-Lok (Griffin Pipe), Flex Ring and Lok-Ring (American), TR Flex (U.S. Pipe) or approved equal.

- b. Restrained joint pipe and fittings shall meet all AWWA standards and other requirements as specified above for standard ductile iron pipe and fittings unless addressed herein.
  - c. Field made joints are allowable but should be avoided where possible. Careful planning to locate field cuts in standard pipe sections is preferred. For field made joints in restrained piping, use field weldments or an insert equal to TR Flex Gripper Rings or approved equal. Gasket type field made joints will not be allowed.
  - d. Restrained joint fittings shall be provided by the restrained joint pipe supplier where located within restrained joint pipe sections. Fittings shall be of the same model and type as the pipe supplied from the pipe manufacturer.
  - e. Restrained joint fittings may be push-on joint type.
  - f. Megalugs, Series 1100, as manufactured by EBAA Iron Sales or approved equal shall be allowable for restraint where approved by the City.
  - g. Contractor shall develop a field layout schedule and drawing for restrained joint pipe installations.
6. Fittings
- a. Fittings shall be made of ductile iron and shall conform to AWWA C110 or C150.
  - b. Fittings to be lined with 40 mils of Protecto 401 Ceramic Epoxy or equal.
- B. Polyvinyl Chloride (PVC) Pipe for Gravity Sewer
1. General
- a. All PVC sewer pipe 4-inches through 15-inches in diameter shall have a minimum Standard Dimension Ratio (SDR) of 35 and shall meet all requirements of ASTM Specification D3034.
  - b. For depths greater than 20 feet, all PVC sewer pipe 4-inches through 15-inches in diameter shall have a minimum Standard Dimension Ratio (SDR) of 26.
  - c. Nominal pipe length shall be a minimum of 13 feet.
2. Joints
- a. Pipe shall have an integral elastomeric-gasket bell end.
  - b. Gaskets shall be in conformance with ASTM F477.
- C. Services
1. General
- a. Unless otherwise directed by the City, pipe for gravity sewer service laterals, including the cleanout stack, shall be PVC Schedule 40 pipe meeting the requirements of ASTM D1785, or ductile iron pipe.
  - b. All service connections to new lines shall be made by installing "wyes".
2. Joints
- a. Joints for PVC service pipe shall be solvent cement welded.

## D. Encasement Pipe

### 1. Materials

- a. Encasement pipe installed under City maintained and NCDOT maintained roadways shall be in accordance with NCDOT's "Policies and Procedures for Accommodating Utilities on Highway Rights-of-Way".
- b. Encasement pipe installed under railroads shall be in accordance with "Part 5.3, Specifications for Pipelines Conveying Non-Flammable Substances" as developed by the American Railway Engineering Association (AREA).
- c. Pipe materials used for the carrier pipe shall be adjusted as needed to meet the requirements of the roadway or railroad owners.
- d. Pipe supports used in the encasement pipe designed and manufactured for the support of the carrier pipe shall be as follows:
  - 1) Band and Riser Material: 14 gauge steel for band and riser except if the riser is over 6-inches high, the steel shall be 10 gauge for riser. Riser shall be of the channel shape. Band with risers shall have a fusion bonded PVC coating of a minimum of 10-mil thickness. Band shall be bolted together with stainless steel bolts, nuts and washers.
  - 2) Band Liner: Provide PVC liner a minimum of 0.09 inches.
  - 3) Runners: Glass Reinforced Polyester or UHMW Polymer plastic. Runner shall be a minimum of 1-inch wide and not more than 1-inch shorter than the bandwidth. Provide 2 top and 2 bottom runners for pipe sizes through 12-inches and 2 top and 4 bottom runners for pipes over 12-inches.
- e. End seals installed on the encasement pipe may be a wrap around or a pull-on type. Seal shall be made of 1/8-inch thick synthetic rubber and shall be secured with stainless steel banding straps with worm gear tightening device. Alternate means of sealing the encasement may be approved by the City.

## 2.02 MANHOLES

### A. General

1. Manholes shall be made of pre-cast concrete sections in conformance with ASTM C478, N.C. Department of Transportation and the following requirements:
  - a. Standard manhole diameter shall be 4 feet unless an inside drop structure is installed or the depth exceeds 15 feet. In these cases the minimum diameter shall be 5 feet.
  - b. Pre-cast concrete manholes shall be as manufactured by Adams Concrete, Carolina Precast Concrete, Inc., D&M Concrete Specialties, Inc., N.C. Products Corp., Stay Right Tank, Tindall Concrete Products, Inc. or approved equal.

## B. Pre-Cast Sections

1. Minimum wall thickness shall be 5-inches.
2. Base: Cast monolithically without construction joints or with an approved PVC waterstop in the cold joint between the base slab and the walls. The width of the base extensions on Extended Base Manholes shall be no less than the base slab thickness.
3. Riser: Minimum lay height of 16-inches.
4. Eccentric Cone: Top inside diameter shall be 24-inches. Width of the top ledge shall be no less than the wall thickness required for the cone section.
5. Transition Cone: Provide an eccentric transition from 60-inch and larger manholes to 48-inch diameter risers, cones, and flat slab top sections. Minimum slope angle for the cone wall shall be 45 degrees.
6. Flat Slab Top: Designed for HS-20 traffic loadings as defined in ASTM C890. Items to be cast into Special Flat Slab Tops shall be sized to fit within the manhole ID and the top and bottom surfaces. Provide a float finish for exterior slab surface.
7. Pre-Cast or Core Holes for Pipe Connections: Diameter of hole shall not exceed outside diameter of pipe by more than 3-inches.
8. Grade Rings: May be used to adjust frame and cover to finished grade.
9. Grade Rings shall be no less than 4-inches in height.
10. Lifting Devices: Devices for handling pre-cast components shall be provided by the pre-cast manufacturer and comply with OSHA Standard 1926.704.

## C. Joints

1. Manufacturer in accordance with tolerance requirements of ASTM C990 for butyl type joints.
2. Minimize number of joints. Do not use riser section for manholes up to 6 feet tall and no more than one riser for each additional 4 feet in height.
3. Flexible Joint Sealants: Preformed butyl rubber based sealant material conforming to Federal Specification SS-S-210A, Type B and ASTM C990.
4. External Seal: Polyethylene backed flat butyl rubber sheet no less than 1/16-inch thick and 6-inches wide.

## D. Inverts

1. Brick and mortar or precast concrete invert.
2. Form and finish invert channel to provide a consistent slope from inlet(s) to outlet up to 4-inches.
3. Channel walls shall be formed to 3/4 of the height of the outlet pipe diameter.
4. Finish benches with a minimum uniform 1.5:12 slope. Provide a 1/4-inch radius at the edge of bench and trough.

## E. Flexible Pipe Connectors

1. Provide flexible connectors for pipe to manhole that conform to ASTM C923.
2. Provide stainless steel pipe clamp type band around flexible connection to sewer pipe.

F. Manhole Steps

1. Steps shall be in accordance with ASTM C478 and made of 1/2-inch grade 60 steel encapsulated by co-polymer polypropylene and have serrated tread and tall end lugs.
2. Secure steps to the wall with compression fit in tapered holes or cast-in-place. Align steps along a vertical wall and shall not be located over a pipe opening. First step shall be a maximum of 26 inches from the bottom.
3. Steps shall be by American Step Co., Inc., Bowco Industries, Inc., M.A. Industries, Inc. or approved equal.

**2.03 CASTINGS**

A. General

1. Made of gray iron, ASTM A-48 - Class 30, or ductile iron, ASTM A536, grade 65-45-12.
2. Castings shall be free from imperfections not true to pattern. Casting tolerances shall be plus or minus 1/16-inch per foot of dimension. Top shall set neatly in frame, with edges machined for even bearing and proper fit to prevent rattling and flush with the edge of frame.
3. Castings shall be as manufactured by Neenah Foundry Co., U.S. Foundry & Manufacturing Corp., or Vulcan Foundry or approved equal.

B. Manhole Frame and Cover:

1. Minimum clear opening shall be 22-inches.
2. Minimum weight for frame and cover shall be 310 pounds and suitable for Heavy Duty Highway Traffic Loads of H-20.
3. Frame shall have four 3/8-inch anchor bolt holes equally spaced.
4. Cast "Sanitary Sewer" on the cover. Casting shall bear the name of the manufacturer and the part number.
5. See details for various types of allowable covers. Utilize as appropriate for the intended application or as directed by the City.
6. Bolt down covers shall be provided with four (4) 3/8-inch stainless steel hex head bolts at 90 degrees.

**2.04 TRANSITION COUPLINGS FOR GRAVITY SEWER PIPE**

- A. For new construction, pipe materials shall be comprised of only a single material between manholes. No changes in material are allowed between manholes.
- B. Pipe material changes between manholes may be permitted (in special circumstances as a repair option) provided there is not a substantial difference in inside diameters, a smooth uniform flow line is maintained and a watertight rubber sleeve or mechanical coupler conforming to ASTM C-425 is used to make the transition. Metal hardware shall be stainless steel. Transition sleeves shall be manufactured by Fernco Strong Back Repair Coupling, Mission Flex-Seal ARC Coupling, Indiana Seal or approved equal.

## **PART 3 EXECUTION / INSTALLATION**

### **3.01 PIPE AND ACCESSORIES**

#### **A. General**

1. Provide erosion control measures as required. Erosion control measures including seeding and mulching shall be designed, installed and maintained in accordance with the N.C. Department of Environmental Quality, Land Quality Section's "Erosion and Sediment Control Planning and Design Manual". The Contractor/Developer/Engineer is responsible for securing all required permits.
2. Pipe installation shall meet the following general guidelines:
  - a. Handle pipe and accessories in accordance with manufacturer's recommendations. Take particular care not to damage pipe coatings.
  - b. Carefully inspect pipe immediately prior to laying. Do not use defective pipe. Replace pipe damaged during construction.
  - c. Lay pipe to design grade and alignment.
  - d. Provide proper equipment for lowering pipe into trench.
  - e. Provide tight closure pipe ends when work is not in progress.
  - f. Keep pipe interior free of foreign materials.
  - g. Do not lay pipe in water or when the trench or weather conditions are unsuitable for the work.
  - h. Clean bell and spigots before joining. Make joints and lubricate gasket in accordance with pipe manufacturer recommendation.
  - i. Block fittings with concrete or restrained joints.

#### **B. Trenching for Underground Pipe Installation**

##### **1. Definitions**

- a. **Backfill:** A specified material used in filling the excavated trench and placed at a specified degree of compaction.
  - 1) **Materials:** Materials listed herein include processed materials plus the soil classifications listed under the Unified Soil Classification System, (USCS) (Method D2487 and Practice D2488). The soil materials are grouped into five (5) broad categories according to their suitability for this application.
    - i. **Class I:** Angular, 6 to 40-mm (1/4 to 1-1/2-in.), graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, and crushed shell.
    - ii. **Class II:** Coarse sands and gravels with maximum particle size of 40 mm (1-1/2 in.), including various graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class.
    - iii. **Class III:** Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Soil Types GM, GC, SM, and SC are included in this class.

- iv. Class IV: Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH and CL are included in this class. These materials shall not be used for bedding, haunching, or initial backfill.
  - v. Class V: This class includes the organic soils OL, OH, and PT as well as soils containing frozen earth, debris, rock larger than 40 mm (1 1/2 in.) in diameter, and other foreign materials. These materials shall not be used for bedding, haunching, or initial backfill.
- 2) Backfill Zones: Each backfill zone shall extend the full width of the trench bottom.
- i. Foundation: Extending down from the bottom of bedding zone as defined below.
  - ii. Pipe Embedment
    - 1. Bedding: Extending from 4 inches below the pipe bottom to the pipe bottom for 30-inch diameter and smaller and 6 inches below the pipe bottom for pipes larger than 30 inches in diameter.
    - 2. Haunching: Extending from the bedding (bottom of the pipe) to the pipe spring line (midpoint).
    - 3. Initial Backfill: Extending from the haunching (pipe spring line) to 1 foot above the top of the pipe.
  - iii. Final Backfill: Extending from the initial backfill to the finish ground elevation.
- b. Laying Conditions:
- 1) Type 1: Flat bottom trench with loose backfill.
  - 2) Type 2: Flat bottom trench with backfill lightly consolidated to centerline of pipe.
  - 3) Type 3: Pipe bedded in 4 inches minimum of loose soil and backfill lightly consolidated to top of pipe.
  - 4) Type 4: Pipe bedded on Class I material to 1/8 pipe diameter (4 inch minimum) Backfill compacted to top of pipe a minimum of 80 percent of standard proctor.
  - 5) Type 5: Pipe bedded in compacted Class I material to pipe centerline with 4-inch minimum under pipe. Backfill to top of pipe with Class I, II, or III and compact to 90 percent of standard proctor.
- c. Compaction: Process of mechanically stabilizing a material by increasing its density at a controlled moisture condition. "Degree of compaction" shall be expressed as a percentage of the maximum dry density obtained by the test procedure presented in ASTM D698 (Standard Proctor).
- d. Excavation: The removal of soil or rock to obtain a specified depth or elevation.
- e. Hard Material: Solid, homogeneous material which is not included in the definition of "rock" but which may require the use of heavy excavation

equipment with ripper teeth. Amount must exceed 1 cubic yard in volume. Material having a standard penetration resistance as determined by ASTM D1586 between 60 and 150 blows per foot is defined as "hard material."

- f. Lift: Layer of soil placed on top of a previously prepared or placed soil.
- g. Rock: Solid, homogeneous material which cannot be removed without the systematic drilling and blasting exceeding 1 cubic yard in volume. Material having a standard penetration resistance as determined by ASTM D1586 greater than 150 blows per foot is defined as "rock." Removal of "hard material" will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production.
- h. Pipe Spring Line: A line running horizontally through the center of the pipe.
- i. Topsoil: Natural, friable soil, representative of productive soils in the vicinity of the site. Topsoil shall be free from roots, stones larger than 1 inch, objectionable weed seeds, toxic substances, and materials that hinder grading, planting, and maintenance operations.

2. Products

- a. Stone
  - 1) Class I material shall be #67 or #78M stone in accordance with NCDOT specifications Section 1005, General Requirements for Aggregate.
- b. Warning and Identification Tape
  - 1) Tape shall be a minimum 3-inch wide polyethylene plastic tape manufactured specifically for identification of buried utilities with means of enabling detection by a metal detector to a minimum depth of 3 feet. Tape shall be color coded and continuously imprinted with warning and identification markings in bold black letters to read "CAUTION - BURIED (utility) LINE BELOW." Color and printing shall be permanent, unaffected by moisture or soil and shall be as follows:

<b>UTILITY</b>	<b>COLOR</b>	<b>MARKING</b>
Water .....	Blue .....	Caution - Buried Water Line Below
Gravity Sewer .....	Green .....	Caution - Buried Sewer Line Below
Force Main .....	Green .....	Caution - Buried Force Main Below
Electric .....	Red .....	Caution - Buried Electric Line Below
Gas .....	Yellow .....	Caution - Buried Gas Line Below
Telephone .....	Orange .....	Caution - Buried Telephone Line Below
SCADA .....	Orange .....	Caution - Buried SCADA Line Below

- 2) Tape shall be by Blackburn Manufacturing, Joseph G. Pollard Co., or Reef Industries Inc., or approved equal.

- c. Tracer Wire
  - 1) Tracer wire shall be #12 solid copper wire. All connections shall be by wire nuts and taped.
  - 2) Splices in tracer wire are to be kept to a minimum and joined with copper split nuts of appropriate size.
- 3. Project Safety
  - a. Contractor is responsible for Project safety.
  - b. Perform work in conformance with applicable State and Federal safety regulations including, but not limited, to the following:
    - 1) North Carolina Safety and Health Standards for the Construction Industry (29CFR 1926 Subpart P).
    - 2) NC OSHA Industry Guide No. 14, Excavations.
    - 3) NC OSHA Industry Guide No. 20, Crane Safety.
  - c. Provide barriers, warning lights, and other protective devices at excavations as necessary for safety of workers and the public.
  - d. Provide sloping of bank, shoring, sheeting, or other means of maintaining the stability of the trench in accordance with the requirements of the Associated Contractor's Manual of Accident Prevention OSHA, Part 1926.P.
- 4. Protection of Underground Facilities
  - a. Investigate underground facility location prior to start of construction.
  - b. Installer is required to contact North Carolina 811 prior to start of construction.
  - c. Repair damage to any existing facilities.
- 5. Water Control
  - a. Prevent surface and/or ground water from entering the trench.
  - b. When trench bottom is below the existing ground water table, install a dewatering system to maintain water table 1 foot below trench bottom. Provide a man experienced in dewatering work at the job site.
  - c. Maintain dewatering until backfilling has proceeded above the existing ground water level.
  - d. Dispose of water from dewatering operations in accordance with the North Carolina Sedimentation Pollution Control Act.
- 6. Use of Explosives
  - a. Explosives may not be used on any excavation unless specifically approved by the City.
  - b. A certificate of insurance listing the City of Clinton as an alternate insured must be provided to the City prior to approval.
- 7. Excavating
  - a. Excavation shall be by open cut method. Short sections of trench may be tunneled or direct bored with the approval of the City.

- b. Stockpile excavated material in such a manner that it will not obstruct the flow of runoff, streams, endanger Work, impair the use or appearance of existing facilities, or be detrimental to the completed Work.
  - c. Contractor shall segregate excavated material so as to maintain material suitable for backfill separate from material that is unsuitable.
  - d. Trench dimensions at the pipe embedment and foundation zone unless noted otherwise shall be as follows:
    - 1) Minimum width: Pipe outside diameter plus 18 inches.
    - 2) Maximum width: Pipe outside diameter plus 24 inches.
    - 3) Sides shall be vertical to a minimum of one foot above the top of pipe.
  - e. Shape trench bedding to provide uniform bearing for the full pipe length. Bottom shall be free of protrusions that could cause point loading on pipe. Provide bell holes as required for properly making pipe joint.
  - f. Do not over excavate. Excavation below grade shall be backfilled with Class I material at no cost to the City.
  - g. Undercut soils that become unsatisfactory by construction activity or by being left exposed to the weather and backfill with Class I material.
  - h. Remove shoring, bracing, and sheeting, unless otherwise noted, as the trench is backfilled.
  - i. Excavation of trench shall not advance more than 200 feet ahead of the installation. In no case should the excavation extend beyond that which can be backfilled by the end of the workday.
  - j. Correct unstable soil conditions encountered at trench foundation by one of the following methods:
    - 1) Excavate below grade as approved by Engineer and backfill with Class I material or approved substitute material.
  - k. Rock and Hard Material
    - 1) Excavate rock and hard material to a minimum depth of 4 inches below the pipe for pipes smaller than 30 inches and 6 inches for pipes 30 inches and larger.
  - l. Gravity Lines:
    - 1) Excavate trench to the design alignment and grade.
  - m. Utility Structures: Provide a minimum of 12 inches below subgrade and backfill with Class I compacted to 95 percent maximum density. If the soil conditions are found to be unsuitable for structural stability of the manhole, City may require additional depth of Class I material.
8. Backfilling
- a. General
    - 1) Temperature must be above freezing and rising.
    - 2) In windy, hot, or arid conditions with a high rate of evaporation add moisture to the material to maintain the optimum moisture content.
    - 3) Do not proceed in rain or on saturated subgrade.

- 4) Do not place material on surfaces that are muddy, frozen, or contain frost.
  - 5) Maintain backfill operation within 200 feet from pipe laying operation.
  - 6) Backfill trench to existing ground surface with select excavated material at the specified compaction.
  - 7) If excavated material is unsuitable to obtain specified compaction, provide suitable off-site borrow material for backfill.
  - 8) Re-excavate trenches improperly compacted. Backfill and compact as specified.
  - 9) Provide appropriate tamping equipment, and water to obtain proper moisture content, to achieve specified compaction of backfill.
  - 10) Conduct operation of heavy equipment above pipe installation as to prevent damage to pipe.
  - 11) Install warning / identification tape over utilities. Bury tape one foot below finished grade above the utility.
  - 12) Install tracer wire for non-metallic pressure pipe. Bury tracer wire with pipe. Wire shall be looped into valve boxes to allow access for direct contact location.
- b. Backfill in pipe embedment zone (bedding, haunching, and initial backfill).
- 1) General
    - i) Backfill with material as specified below. Material shall be free from objects larger than 2 inches.
    - ii) Where rock and hard material has been excavated below pipe bottom, backfill and compact bedding with Class I material. Class II or III material may be used for bedding with Engineer's approval.
    - iii) Place backfill material to assure placement of material under pipe haunches.
    - iv) Take care during placement and compacting of material to avoid movement of pipe.
  - 2) Place backfill in bedding and haunching zones in 6 inch maximum lifts and compact to 90 percent density. Place initial backfill in one lift do not compact. Provide backfill material in pipe embedment zone as specified below.
    - i) Pressure Lines (Flexible and Rigid Pipe)
      1. Excavation in Class I, Class II, and Class III soils suitable for bedding, the bedding surface shall provide a firm foundation of uniform density. Backfill with select excavated material.
      2. Excavation in Class IV or Class V, running water, and other unstable soil conditions, excavate a minimum of 4 inches below pipe bottom and provide Class I material for bedding and haunch zone. Backfill with Class I, II, or III material in initial backfill.

3. Ductile Iron over 16 inch
    - a) Depth 0 - 12 feet: Type 2 laying conditions same as for pressure pipe.
    - b) Depth over 12 feet: Provide Class I material for bedding and 4 inches up from bottom of pipe.
  - ii) Gravity Sewer Lines, Rigid Pipe and Ductile Iron
    1. Excavation in Class I, Class II, Class III, and stable Class IV soils suitable for bedding, the bedding surface shall provide a firm foundation of uniform density. Backfill with select excavated material.
    2. Excavation in Class V, unstable Class IV soils, running water, and other unstable soil conditions, excavate a minimum of 4 inches below pipe bottom and provide Class I material for bedding and haunch zone. Backfill with Class I, II, or III material in initial backfill.
  - iii) Gravity Sewer Lines, Flexible (PVC SDR 35)
    1. Depth 0 to 14 ft: Provide Class I material for bedding and haunching. Backfill with Class I, II, or III material in initial backfill.
    2. Depth over 14 ft: Provide Class I material for bedding, haunching, and initial backfill.
- c. Final Backfill
- 1) Backfill with materials free of stones and free of debris larger than 6 inches in dimension. Place backfill in lifts not exceeding the thickness and compacted to the minimum density specified below.
  - 2) Trench backfilled with non-cohesive materials may be compacted with water flooding; except under roadways, shoulders of roadways, and other areas subject to vehicular movement, provided the method of compaction is approved by the City and provides the degree of compaction required.
  - 3) Lifts and density:
    - i) Undeveloped areas (i.e., forests, fields, and, croplands): Trench may be filled with bulldozer blade provided material fall will not damage pipe. Mound soil over the trench area sufficiently to settle level over time. Degree of compaction shall be 85 percent.
    - ii) Lawns: Backfill in 12-inch lifts and compact to 90 percent. Top 12 inches shall be free of material with a dimension over 2 inches.
    - iii) Roads (including rights-of-way), drives, parking areas (including areas within 20 feet), and adjacent to existing utilities: Backfill in 6 inch lifts compact to 95 percent.
    - iv) Within 20 feet of foundations: Backfill in 6-inch lifts compacted to 95 percent.

- d. Utility Structures: Bring backfill to grade in even lifts on all sides. Lift depths and compaction densities shall be as specified according to area of installation for pipe above. Backfill against cast-in-place concrete structure only after concrete has attained the specified 28-day compressive strength.

C. Relation of Sewer to Water Main, Wells and Storm Sewer

1. Lateral Separation: Lay at least 10 feet laterally from existing and proposed water main. Where existing conditions prevent a 10-foot lateral separation, the following shall be followed with approval of the City:
  - a. Lay sewer in a separate trench, with the elevation of the top of the sewer at least 18-inches below the bottom of the water line.
  - b. Lay sewer in the same trench as the water main with the sewer main located at one side on a bench of undisturbed earth, and with the elevation of the top of the sewer at least 18 inches below the bottom of the water line.
2. Crossing Separation: Lay top of sewer at least 18 inches below the bottom of the water. Where existing conditions prevent an 18-inch vertical separation, construct both the water main and sewer 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 and sewer line must be pressure tested to 150 psi to insure water tightness.
3. Crossing a Sewer Over a Water Main: When it is necessary for a sewer to cross over a water main, construct both the water main and the sewer 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.
4. A 24-inch vertical separation shall be provided between sanitary sewers and storm sewers or ferrous pipe specified.
5. Lay sewer pipe to true lines and grades by use of laser beam equipment or other acceptable means.
6. Minimum Separation Distances:
  - a. 100-foot horizontal separation from wells or other water supplies.
  - b. 24-inch vertical separation from storm sewers or ferrous pipe shall be used.

D. Ductile Iron Pipe

1. Install pipe in conformance with AWWA C600 and the following:
  - a. For laying pipe in a vertical or horizontal curve, each full length pipe may be deflected by the following offset distance:
    - 1) Push-on joint
      - i) 3 to 12-inch pipe: 14-inch offset
      - ii) 14 to 36-inch pipe: 8-inch offset
    - 2) Mechanical joint
      - i) 3 to 6-inch pipe: 20-inch offset
      - ii) 8 to 12-inch pipe: 15-inch offset

- iii) 14 to 20-inch pipe: 8-inch offset
- iv) 24 to 36-inch pipe: 6-inch offset
- b. For laying restrained joint pipe in a vertical or horizontal curve, except for horizontal directional drills (HDD), each full length pipe may be deflected by the following offset distance:
  - 1) 6 to 12-inch pipe: 11-inch offset
  - 2) 16 to 20-inch pipe: 7-inch offset
  - 3) 24 to 30-inch pipe: 5-inch offset
  - 4) 36-inch pipe: 4-inch offset
  - 5) 42 to 48-inch pipe: 1 ¼ -inch offset

#### E. Encasement Pipe

##### 1. General

- a. Verify the subsurface conditions at each boring site.
- b. Stabilize and maintain bore pit bottom to provide proper equipment support and maintain pipe alignment. Dewater as necessary for site. Excavate bore pit in accordance with OSHA regulations. Provide adequate barricades, railings, and warning lights throughout the boring operation. Conduct operation in such a manner so as not to create a hazard to, nor impede the flow of traffic.
- c. Install encasement pipe by dry boring and jacking.
- d. Boring auger diameter shall not be greater than the outside diameter of the encasement pipe and shall not extend more than 6-inches ahead of the cutting edge of the encasement pipe. Fill voids that are formed during the operation with a 1:3 portland cement grout pumped at 50 psi to ensure that there will be no settlement of the roadway.
- e. As the boring operation progresses, butt weld each new section of the encasement pipe to the section previously jacked into place. Maintain proper alignment. Confirm the grade of the encasement pipe as the Work progresses.
- f. If an obstruction is encountered during the boring operation, efforts should be made to remove the obstruction. If obstruction cannot be removed, withdraw the encasement pipe and fill the void with 1:3 portland cement grout at 50 psi. If the encasement pipe cannot be withdrawn, seal ends before moving to another bore site. City shall approve location of new bore site.
- g. Provide seals at each end of encasement pipe.

##### 2. Carrier Pipe

- a. Install carrier pipe in the encasement pipe using manufactured pipe supports. Supports shall prevent movement of the carrier pipe within the encasement. Space supports as specified.

## F. Sewer Cleanouts

### 1. General

- a. Sewer cleanouts connected to ductile iron pipe shall also be ductile iron sewer pipe conforming to these specifications.
- b. Sewer cleanouts connected to PVC pipe shall also be PVC sewer pipe schedule 40 conforming to ASTM-D-3034 latest revision. Use elastomeric gaskets for pipe joints.
- c. Service wyes shall be used on new PVC pipe. Service saddles shall be used on existing PVC, solvent welded to the main and fastened with double stainless steel bands.
- d. Cleanouts shall be a minimum of 4-inch diameter. Provide sewer cleanouts with screw-in watertight cap. Installation shall be in accordance with the standard detail, or as approved by the City's Public Works and Utilities Department.

## G. Service Connections

### 1. General

- a. Make service connections in accordance with the standard detail.
- b. Service connections to the main lines shall be perpendicular to the main line to the edge of the right-of-way or easement line.
- c. Four-inch lines shall have a minimum slope of 1.0 % and have cleanouts every 75 feet at a minimum in addition to a cleanout at the right-of-way line or at the edge of the easement.
- d. Six-inch lines shall have a minimum slope of 0.60 % and have cleanouts every 100 feet at a minimum in addition to a cleanout at the right-of-way line or at the edge of the easement.
- e. 6-inch service lines shall tie directly into a manhole.
- f. Service lines, which are connected into manholes, shall be installed less than 2.5 feet above the invert or shall be installed as a standard drop.
- g. If a sidewalk is present or proposed, the cleanout shall be located behind the sidewalk.

## H. Anti-Seep Collars

### 1. General

- a. Anti-seep Collars: Provide anti-seep collars to prevent groundwater flow along pipe in wetlands. Collars shall extend past trench walls and bear against undisturbed soils. Dimension of collars shall be as indicated on the standard details. Do not place stone in area of anti-seep collars.
- b. Concrete Collar: Provide Class B concrete with minimum cement content of 5 sacks per cubic yard (5.5 sacks for angular course aggregate); 6.8 gallons of water per sack water-cement ratio; 2-4 inch slump range; and 28-day strength of 2,500 psi.

## I. Pavement Patching

### 1. General

- a. Repair damaged pavement structure.

- b. Cut existing pavement for utility installation in straight lines generally parallel to the utility. Properly dispose of removed pavement structure.
- c. Extend pavement patch 1 foot beyond each side of trench on firm subgrade. Slope new surface to drain.
- d. Asphalt Pavements: Replace asphalt pavement with a pavement structure no less than as shown on the Standard Details. For roadways under NC Division of Highways jurisdiction, pavement shall be replaced in accordance with their requirements.
- e. Concrete Pavements: Replace concrete pavement with pavement structure equal to existing but no less than 6 inches. Concrete shall be minimum 3,000 psi. When existing concrete joint is within 5 feet of trench remove existing concrete to joint. Provide expansion joint at edge of existing concrete. Surface treatment shall match existing.
- f. Curbs, Gutters, and Sidewalks: Replace curbs and gutters, and sidewalks removed or damaged with similar sections to match the existing. Remove to nearest existing joint.
- g. Approval of Other Authorities: Pavements under the jurisdiction of the NC Division of Highways shall be subject to the approval of a representative of that Division.

J. Grading and Clean-Up

1. General

- a. Provide for testing and clean-up as soon as practical, so these operations do not lag far behind the pipe installation. Perform preliminary clean-up and grading as soon as backfill is complete.
- b. Provide positive drainage of finished grade and drain away from structures. Finished grade shall be reasonably smooth, compacted, free from irregular surface changes and comparable to the adjacent existing ground surface.
- c. Seed disturbed areas.
- d. Upon completion of backfilling, remove and properly dispose of excess material and waste.

**3.02 MANHOLES**

A. General

- 1. Set base plumb and level. Align manhole invert with pipe invert.
- 2. Secure pipe connectors to pipe in accordance with manufacturer's recommendation.
- 3. Clean bells and spigots of foreign material that may prevent sealing. Unroll the butyl sealant rope directly against base of spigot. Do not stretch. Follow manufacturer's instructions when using O-ring seals.
- 4. Set precast components so that steps align.
- 5. Plug lift holes using a non-shrink grout. Cover with a butyl sealant sheet on the outside and seal on the inside with an application of an epoxy gel 1/8-inch thick extending 2 inches beyond the opening.

6. Set manhole frames to grade with grade rings. Seal joints between cone, adjusting rings, and manhole frame with butyl sealant rope and sheet.
7. Apply external seal to the outside of joint.
8. Finish the interior by filling fractures greater than 1/2-inch in length, width or depth with a sand cement mortar.
9. Clean the interior of the manhole of foreign matter
10. Ring and Cover shall be installed in accordance with Standard Details.

## **PART 4 TESTING AND START-UP**

### **4.01 PIPE AND ACCESSORIES**

#### **A. General**

1. Clean and flush pipe system of foreign matter prior to testing.
2. Notify the City a minimum of 48 hours prior to testing.
3. Perform tests in the presence of the City, and provide documentation to such tests and results to the City.
4. Length of line to be tested at one time shall be subject to approval of the City.
5. Pipe sections shall not be accepted and placed into service until specified test limits have been met.
6. Repair defects in the pipe system. Make repairs to the same standard as specified for the pipe system.
7. Retest repaired sections until acceptance.
8. Repair visible leaks regardless of the test results.

#### **B. Gravity Sewer Mains**

1. Test gravity lines between manholes.
2. Light Testing: City will check for displacement of pipe as follows:
  - a. A light will be flashed between the ends of the pipe section being tested.
  - b. If the illuminated interior shows misalignment, or other defects as designated by the City, defects shall be repaired.
3. General
  - a. Infiltration shall not exceed 100 gallons per inch of diameter, per mile of pipe, per 24 hours. Engineer may require flow measurement for verification of infiltration.
  - b. Verify that maximum infiltration rate shall not be surpassed by air testing as follows.
4. Low Pressure Air Test:
  - a. Air testing of sewer mains shall conform to UNI-B-6 and the following requirements:
  - b. Perform initial air test when each section of main is complete including services to right of way. Test as construction proceeds.
  - c. Wet interior surfaces of porous pipe material prior to testing.

d. Safety

- 1) Provide a superintendent who has experience in low pressure air testing of gravity sewer mains.
- 2) Follow safety recommendations of air testing equipment manufacturer.
- 3) Properly brace sewer plugs during testing. Test plugs prior to use in air testing.
- 4) No one shall be allowed in manhole or trench when pipe is under pressure.
- 5) Pressurizing equipment shall include a regulator and a pressure relief valve, which are set no higher than 9 psig. Monitor gauges continuously to assure that the pressure does not exceed 9 psig.

e. Equipment

- 1) Sewer plugs shall be specifically designed for low pressure air testing.
- 2) Use two separate air hoses.
  - i) One to connect the control panel to the sealed line for introducing the air.
  - ii) One from the sealed line to the control panel to provide constant monitoring of the air pressure in the line.
  - iii) If Pneumatic plugs are used a separate line shall be used to inflate the plugs.
- 3) As a minimum the above ground air testing equipment shall include a shutoff valve, pressure regulating valve, pressure relief valve, input pressure gauge, and a continuous monitoring pressure gauge having a pressure range from 0 to at least 10 psig.
- 4) Continuous monitoring pressure gauge shall be at least 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of +/- 0.04 psi.
- 5) Monitoring gauges shall be subject to calibration as deemed necessary.
- 6) Air used for testing shall pass through a single above ground control panel.

f. Testing

- 1) Groundwater Determination: Immediately prior to each air test, determine groundwater level by a method acceptable to the Engineer. Adjust pressure used in air test in accordance with groundwater level.
- 2) Apply air slowly to the test section until the pressure reached is 4.0 psi plus an adjustment of 0.433 psi for each foot of ground water above the crown of the pipe. Internal air pressure, including adjustment for ground water, should never exceed 9.0 psi.
- 3) When the above required pressure is reached, throttle air supply to maintain internal pressure for at least two minutes to permit stabilization.

- 4) When pressure has stabilized at required pressure, shut off air supply.
  - 5) While observing the continuous monitoring pressure gauge, decrease pressure approximately 0.5 psi from required pressure.
  - 6) At this reading timing shall commence with a stop watch and allowed to run until pressure has dropped 1.0 psi or allowable time has lapsed. Line shall be "Acceptable" if the pressure drop does not exceed 1 psig in the time prescribed for the test in Standard Detail, S-1.21, Low Pressure Air Testing for Gravity Sewer Mains.
5. Deflection Test for SDR 35 and C-900 PVC Pipe
    - a. Measure for deflection of pipe no sooner than thirty (30) days after installation and backfill.
    - b. Deflection shall not exceed 5 percent of pipe diameter. Maximum allowable long term deflection shall be 5 percent.
    - c. Measure deflection with an approved "GO-NO-GO GAUGE" method or by an approved recording deflectometer. Verify gauge on site prior to testing.
  6. When gravity sewer mains do not meet the required minimum separation from wells, water mains or streams, hydrostatic testing shall be performed as follows:
    - a. The source, quality, and method of disposal of water to be used in test procedures shall be approved by the City.
    - b. Contractor shall obtain City's permission 48 hours prior to filling or flushing of pipe system. City shall operate valves connected to the existing water system.
    - c. Air test line, as described above, prior to hydrostatic testing.
    - d. Provide taps for filling and pressurizing the line. Service corporation stops may be used. Include cost of taps in price of testing. Leave corporation stops in place after testing and note locations on As-Constructed Drawings.
    - e. Suitable means for thrust restraint shall be installed for testing.
    - f. Test for each manhole reach.
    - g. Test pipe by maintaining for a two-hour period a hydrostatic pressure of 150 psig.
    - h. Test pressure shall not vary by more than +/- 5 psi for the duration of the test.
    - i. Pressure test in accordance with AWWA C600 for ductile iron pipe and as described above.

#### **4.02 MANHOLES**

##### **A. General**

1. Vacuum test each manhole in accordance with ASTM C1244 and the following:
  - a. No personnel shall be allowed in manhole during testing.
  - b. Test manhole after assembly and prior to backfilling.
  - c. Plug pipes with suitably sized and rated pneumatic or mechanical pipeline plugs. Brace plugs to prevent displacement.

- d. Position vacuum test head assembly to seal against interior surface of the top of cone section in accordance with manufacturer's recommendation.
- e. Draw vacuum of 10 inches of mercury on manhole. Shut off the vacuum pump and close valve on vacuum line.
- f. Measure time for vacuum to drop to 9 inches of mercury. Manhole shall pass if time meets or exceeds the following:
 

<b>Manhole I.D. (inches)</b>	<b>48</b>	<b>60</b>	<b>72</b>	<b>84</b>	<b>96</b>	<b>120</b>
<b>Seconds</b>	<b>60</b>	<b>75</b>	<b>90</b>	<b>105</b>	<b>120</b>	<b>150</b>
- g. If manhole fails test, remove head assembly, coat interior with a soap and water solution, and repeat vacuum test for approximately 30 seconds. Leaking areas will have soapy bubbles. Make necessary repairs to the satisfaction of City and repeat test until manhole passes.

**4.03 CLOSED CIRCUIT TVING OF GRAVITY LINES**

A. General

- 1. Following installation of gravity lines, Contractor shall visually inspect each line by means of close-circuit television (CCTV). Video shall be recorded on a DVD, and copies shall be provided to the City's Public Works and Utilities Department.
- 2. 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 for the entire periphery of the pipe. Camera shall be operative in 100 percent humidity conditions. Components of the video system shall be capable of producing a minimum 310 line resolution. Lighting system shall minimize reflective glare. Camera shall move through at a constant rate with a maximum speed of 30 feet per minute.
- 3. Deliver DVD to the City for review prior to final acceptance.

**4.04 "AS-CONSTRUCTED" DRAWINGS**

A. General

- 1. Maintain on-site a full set of record drawings for purpose of recording as-constructed conditions.
- 2. Information should be legibly recorded as construction progresses.
- 3. Clearly and completely identify any field changes from the original drawings.
- 4. The depth of all force mains shall be recorded at all roadways, waterway crossings, utilities crossings and all other areas as needed to accurately define the vertical location of the force main. A minimum of one depth shall be recorded on each 100 feet of pipe installed. Depth shall be referenced to finished surface grades.
- 5. Show horizontal and vertical location of any existing underground utilities encountered during construction.
- 6. Submit document to the City for review prior to final acceptance.
- 7. All new features shall be surveyed utilizing survey grade GPS equipment and digital file with all surveyed information shall be provided to the City.

8. A digital CADD file, as well as a field mark-up PDF version, shall be provided to the City that contains all the features constructed with the updated as-built information along with survey data. These will be reviewed prior to approval.
9. The City shall have the right to employ an independent survey firm to verify the "As-Constructed" Drawings submitted by the Contractor/Developer/Engineer at the end of the project. If components or the drawings are determined to be incorrect, the Contractor/Developer/Engineer shall have all items corrected to obtain final approval by the City. Contractor/Developer/Engineer will also be responsible for reimbursing the City for all associated costs related to verification, review, and other costs arising from any corrections having to be made in order to provide correct plans and files to the City.

**END OF SECTION**

GRAVITY