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SECTION 02400

STORM DRAINAGE

PART 1 - PRODUCTS

1.01 PIPE:

A. Concrete Pipe - Shall be reinforced Class III and shall conform to ASTM Specification C-76.

1. Joints - Shall be water tight flexible rubber gasket and shall meet ASTM Specification C-443 and AASHTO M-198.

2. Filter Fabric - Mirafi 140N or equivalent.

3. Concrete pipe shall be designed with no lifting holes. The lifting holes will jeopardize the structural integrity and hydraulic capacity of the pipe once installed.

4. A minimum depth of 12 inches cover is required for RCP Class III.

B. Plastic Pipe - To be used for subgrade drainage shall be rigid heavy duty corrugated polyethylene perforated pipe manufactured by Advance Drainage Systems (ADS), or accepted equivalent, and shall conform to AASHTO M 252. The use of coiled tubing is not permitted and will be rejected.

1.02 DRAINAGE STRUCTURES:

A. Details - See plans.

B. Concrete - Reinforced and non-reinforced.

1. Shall have a compressive strength of 3,000 PSI in 28 days. Concrete shall be ready mixed conforming to ASTM C-94.

2. Reinforcing steel shall conform to ASTM A-615, Grade 60. Mesh reinforcing shall conform to ASTM A-185. Reinforcing shall be covered by a minimum 1" of concrete for covers and 1-1/2" for walls and flooring and 3" where concrete is deposited directly against the ground.

3. Expansion joint filler materials shall conform to ASTM Specification D-1751, to AASHTO M-90 or shall be resin impregnated fiberboard conforming to the physical requirements of ASTM Specification D-1752.

C. Mortar:

1. Mortar used at connections of pipe and drainage structures shall be composed of one part by volume of portland cement and two parts of sand. The portland cement shall conform to ASTM C-150, Type I or II. The sand shall conform to AASHTO Standard M-45 and shall be of an accepted gradation. Hydrated lime may be added to the mixture of sand and cement in an amount equal to 25% of the volume of cement used. Hydrated lime shall conform to ASTM C-141, Type A. The quantity of water in the mixture shall be sufficient to produce a workable mortar, but shall in no case exceed 7 gallons of water per sack of cement. Water shall be clean and free of harmful acids, alkalies and organic impurities. The mortar shall be used within 30 minutes from the time the ingredients are mixed with water.

D. Brick Masonry - Brick shall conform to ASTM Specification C-62, Grade SW or C-55, Grade P-I or P-II. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in the amount not more than 25% of the volume of cement. The joints shall be completely filled and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with ½-inch of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course, and for round structures, brick shall be laid radially with every sixth course a stretcher course.

E. Precast - Shall be constructed in accordance with ASTM C-478 and conform to the details on the project drawings.

1. Joints - Shall be tongue and groove sealed with flexible gaskets or mastic sealant. Gaskets shall be O-Ring or Type A or B "Tylox" conforming to A.S.T.M. C-443 and mastic shall be "Ram-nek", or equivalent, with primer. The primer shall be applied to all contact surfaces of the manhole joint at the factory in accordance with the manufacturer's instructions.

2. Steps - Shall be aluminum alloy equivalent to Neenah R-1982-W or polypropylene equivalent to M.A. Industries, Type PS-1 or PS-1-PF. The steps shall be installed at the manhole factory and in accordance with the recommendations of the step manufacturer. Manholes will <u>not</u> be acceptable if steps are not installed accordingly, and properly aligned vertically.

3. Leaks - No leaks in the manhole will be acceptable. All repairs made from inside the manhole shall be made with mortar composed of one part portland cement and two parts clean sand; the mixing liquid shall be straight bonding agent equivalent to "Acryl 60".

F. Frames, Covers & Grates shall conform to the details shown on the project drawings. Grates in pavement and in other flush-mounted type surfaces shall be of a "bicycle-safe" configuration consisting of 45 degrees diagonal bars or slotted grates with a maximum clear opening of 1" and a maximum length of 4". In any case, the long dimension of the openings shall be located transverse to the direction of traffic.

1.03 STONE BACKFILL:

A. Shall be graded crushed granite with the following gradation:

Square Opening Size	Percent Passing by Weight
1"	100%
3/4"	90% to 100%
3/8"	0% to 65%
No. 4	0% to 25%
No. 100	0% to 10%

1.04 SAND BACKFILL:

A. Shall be free from clay and organic material. Not more than 10% shall pass the No. 100 sieve.

1.05 BORROW:

A. Where it is determined by the Engineer that sufficient suitable material is not available from the site to satisfactorily backfill the pipe to at least 2 feet above the top of the pipe, the Contractor shall furnish suitable sandy borrow material to accomplish the requirements. The material shall have not more than 60% passing the No. 100 sieve, nor more than 20% passing the No. 200 sieve.

PART 2 - EXECUTION & TESTING

2.01 LOCATION AND GRADE:

A. The line and grade of the sewer and ditches and the position of all manholes and other structures are shown on the drawings. The grade line as given on the profile or mentioned in these specifications means the invert or bottom of the inside of the pipe or bottom of ditch.

The Contractor shall be responsible for the proper locations and grade of the sewers. The pipe line shall be straight and show a uniform grade between manholes.

2.02 EXCAVATION FOR PIPE:

A. Excavated material shall be piled a sufficient distance from the trench banks to avoid overloading to prevent slides or cave-ins.

B. Remove from site all material not required or suitable for backfill.

C. Grade as necessary to prevent water from flowing into excavations.

D. Remove all water accumulating in the excavation from surface flow, seepage or otherwise, by pumping or other accepted method.

E. Sheeting, bracing or shoring as necessary for the protection of the work and safety of personnel.

2.03 TRENCHING FOR PIPE:

A. Trenching for Pipe - The width of trenches at any point below the top of the pipe shall not be greater than the outside diameter of the pipe, plus 2'-0" for pipes measuring through 30-inches, and 3'-0" for pipes greater than 30-inches, to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipes. Sheeting and bracing where required shall be placed within the trench width as specified. Care shall be taken not to over-excavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures shall be necessary. Cost of this re-design and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Owner.

B. Removal of Unstable Material - Where wet or otherwise unstable soil, incapable of supporting the pipe, as determined by the Owner, is encountered in the bottom of the trench, such material shall be removed to the depth required and replaced to the proper grade with select material, compacted as provided in Paragraph 2.08,"BACKFILLING PIPE", hereinafter.

2.04 BRACING AND SHEETING:

A. The sides of all trenches shall be securely held by stay bracing, or by skeleton or solid sheeting and bracing, as required by the soil conditions encountered, to protect the adjoining property and for safety. Where shown on the drawings or where directed by the Owner, the Contractor must install solid sheeting to protect

adjacent property and utilities. The sheeting shall be steel or timber and the Contractor shall submit design data, including the section modules of the members and the arrangement for bracing at various depths, to the Engineer for review before installing the sheeting. It shall penetrate at least 3 feet below the pipe invert. Sheeting shall be removed in units when the backfilling has reached the elevation necessary to protect the pipe, adjoining property and utilities.

When sheeting or shoring above the elevation cannot be safely removed, it shall be left in place. Timber left in place shall be cut off at least 2 feet below the surface. No separate payment shall be made for bracing and sheeting except where shown on the drawings or authorized by the Owner.

2.05 BEDDING:

A. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. The trench bottom shall be dewatered before laying pipe by the use of well points. Where the nature of the soil is such that well points will not remove the water, the Contractor shall construct sumps and use sump pumps to remove all water from the bedding surface. The pipe shall be carefully bedded in a soil foundation that has been accurately shaped and rounded to conform to the lowest one-fourth (1/4) of the outside portion of circular pipe, or to the lower curved portion of arch pipe for the entire length of the pipe. When necessary, the bedding shall be tamped to compact it to 98% of optimum density. Bell holes and depressions for joints shall be only of such length, depth and width as required for properly making the particular type joint.

B. Stone Backfill - Where, in the opinion of the Engineer, the subgrade of the pipe trench is unsuitable material, the Contractor shall remove the unsuitable material six inches (6") deep and furnish and place stone backfill in the trench to stabilize the subgrade. The stone shall be 3/4-inch graded but variations in the gradation will be permitted upon acceptance by the Engineer. Attention is invited to the fact that the presence of water does not necessarily mean that stone backfill is required. If well points or other types of dewatering will remove the water, the Contractor shall be required to completely dewater the trench in lieu of stone backfill. Stone backfill will be limited to areas where well pointing and other conventional methods of dewatering will not produce a dry bottom. Pipe shall be carefully bedded in the stone as specified above.

C. Sand Backfill - Where in the opinion of the Engineer, the character of the soil is such that the material even though dewatered is unsuitable for pipe bedding, an

additional foot of excavation shall be made and replaced with clean sand furnished by the Contractor.

2.06 PLACING PIPE:

A. Each pipe shall be carefully examined before being laid, and defective or damaged pipe shall not be used. Pipe lines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. All pipe in place shall have been checked before backfilling. When storm drain pipe terminates in a new ditch, the headwall or end section together with ditch pavement, if specified, shall be constructed immediately as called for on the plans. Ditch slopes and disturbed earth areas shall be grassed and mulched as required. The Contractor will be responsible for maintaining these newly constructed ditches and take immediate action subject to acceptance to keep erosion of the ditch bottom and slopes to a minimum during the life of the contract. No additional compensation will be given to the Contractor for the required diversion of drainage and/or dewatering of trenches. Grassing of the completed earth surface of the trench backfill shall conform to the technical specification for Grassing.

B. Concrete Pipe - Laying shall proceed upgrade with the spigot ends of bell and spigot pipe and the tongue ends of tongue and groove pipe pointing in the direction of the flow.

2.07 JOINTS IN PIPES:

A. Concrete Pipe - Flexible watertight joint shall be made with rubber-type gaskets for concrete pipe. The design of joints and the physical requirements for rubber-type gaskets shall conform to ASTM Specification C-443 or AASHTO Standard M-198. Gaskets and jointing materials shall have not more than one splice, except that two splices of the rubber gasket type will be permitted if the nominal diameter of the gasket exceeds 54-inches.

1. Installation of Filter Fabric at Joint - After each joint is joined together, the Contractor shall place two layers of filter fabric around the joint a minimum width of four feet, centered on the joint.

2.08 BACKFILLING PIPE:

A. After the bedding has been prepared and the pipe installed, select material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of the pipe in layers not exceeding six-inches (6") in compacted depth. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. Care shall be taken to insure thorough compaction of the fill under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compaction shall continue until the fill has reached an elevation of at least 12-inches above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical tampers or rammers in layers not to exceed 8-inches. Soil density relations tests and moisture density relations tests may be performed by a testing firm or laboratory and shall be taken as directed in conformance with the compaction requirements specified in subparagraph "COMPACTION" hereinafter. Deficiencies shall be corrected by the Contractor without additional cost to the Owner. Where it is necessary in the opinion of the Owner, any sheeting and/or portions of bracing used shall be left in place. Untreated sheeting shall not be left in place beneath structures or pavements.

B. For pipe placed in fill sections, the backfill material and the placement and compaction procedures shall be as specified above and in subparagraph "COMPACTION" hereinafter. The fill material shall be uniformly spread in layers longitudinal on both sides of the pipe, not exceeding six inches (6") in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12-inches above the top of the pipe shall extend a distance of not less than twice the outside diameter on each side of the pipe or 12 feet, which ever is less. After the backfill has reached at least 12-inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8-inches.

C. In compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert at any stage of the construction shall be at the Contractor's risk. Any pipe damaged thereby shall be repaired or replaced at the expense of the Contractor.

2.09 COMPACTION:

A. Soil and compaction tests shall be made by a testing laboratory accepted by the Owner and shall be made at the Owner's direction and expense. Failed tests shall be rescheduled at the Owner's direction and retesting shall be paid for by the Contractor. Laboratory tests of the soil shall be made in accordance with AASHTO Method T-99. In-place density tests shall be made in accordance with AASHTO Method T-191 or T-238. Results of the tests shall be furnished to the Owner by the testing laboratory.

The minimum number of tests required shall be:

Backfill over pipe in traffic areas . . .	1 per 100 lf or less for each 4 feet of depth or portion thereof. (Minimum of 2 for any line segment.)
Backfill over pipe in non-traffic areas . .	1 per 200 lf or less for each 6 feet of depth or portion thereof.

The minimum percent of compaction of the backfill material (in accordance to AASHTO T-99) shall be the following:

In traffic areas . . .	100%
In non-traffic areas .	95%

2.10 DRAINAGE STRUCTURES:

A. Drainage structures shall be constructed of the materials specified for each type and in accordance with the details shown on the drawings.

2.11 MANHOLES:

A. Manholes shall be constructed where shown on the drawings or where directed by the Owner. The channel in the bottom of the manholes shall be smooth and properly shaped. Special care must be exercised in laying the channel in adjacent pipes to grade. The tops of manholes shall be built to grades designed by the Owner. Manhole sections with either honeycomb defects; exposed reinforcing; broken/fractured tongue or groove; or cracked walls will be subject to rejection by the Engineer for use on the project. When mastic sealant is used, improperly applied primer will also be cause for rejection.

2.12 LEAKAGE:

A. All visible leaks shall be repaired, regardless of the amount of leakage.

2.13 CONNECT PIPE TO EXISTING STRUCTURES:

A. The Contractor shall connect the system to the existing structure where indicated. A hole not more than 4-inches larger than the outside diameter of the new pipe shall be cut neatly in the structure, the new pipe laid so that it is flush with the inside face of the structure, and the annular space around the pipe filled with a damp, expanding mortar or grout to make a watertight seal.

2.14 CLOSING PIPE:

A. When the work or pipe laying is suspended, either for night or at other times, the end of the sewer must be closed with a tight cover. The Contractor will be held responsible for keeping the sewer free from obstructions.

2.15 REGRADE EXISTING DITCH:

A. Designated existing ditches shall be regraded and shaped to provide a bottom with a uniform slope, without depressions that hold water, and that conforms to the plan grades. The side slopes shall be smooth and uniform, dressed by hand if necessary, conforming to the indicated slopes.

2.16 CONSTRUCT NEW DITCHES:

A. New ditches as shown on the construction drawings shall be graded and shaped to provide a bottom with a uniform slope, without depressions that hold water, and that conforms to the plan grades. The side slopes shall be smooth and uniform, dressed by hand if necessary, conforming to the indicated slopes. Ditches with side slope greater than 3:1 (Horizontal: Vertical) shall be stabilized by means of woven jute fabric engineered for erosion control and soil stabilization, or approved equal.

2.17 CLEANING:

A. Prior to televising and before acceptance of the storm systems, all storm lines shall be cleaned to the satisfaction of the Engineer. Where any obstruction occurs, the Contractor will be required to clean the lines by means of flushing and rods and swabs or other instruments.

2.18 TELEVISING:

After the completion of cleaning, all constructed storm lines must be televised by the City prior to acceptance. Accordingly, all storm lines that are installed within accepted public right-of-ways and easements will be televised, including the first section of private lines between manholes that are connected to the public lines. In addition, storm lines from stormwater detention basins to the City system shall be televised. Contractors will be charged a fee, currently $0.85/L.F. for all sizes, and will be responsible for preparing the lines to insure that they are cleaned and free of debris prior to televising. Details and procedures of this program are included in the "Televising Procedures Manual" developed by the City's Water Quality Control Department who will be providing the television services. Contractors will be responsible for becoming familiar with this manual.

2.19 RECORD DATA:

A. As required under Section 1500, Paragraph 54, of the General Conditions, the Contractor is required to keep accurate, legible records of the location of all new storm lines and structures during construction. These records will be made available to the Engineer before his final review for incorporation into the consulting Engineer's Record Drawings. Final payment to the Contractor will be withheld until all such information is received and accepted.

END OF SECTION

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SECTION 02485

GRASSING

PART 1 - PRODUCTS

1.01 MATERIALS GENERAL:

A. The Contractor shall, at the time of delivery, furnish the Engineer invoices of all materials, received in order that the application rate of materials may be determined.

1.02 FERTILIZER:

A. 10-10-10, commercial fertilizer of accepted type, conforming to state fertilizer laws.

1.03 LIME:

A. Lime shall be agricultural grade, ground limestone and shall conform to the requirements of the Georgia Department of Agriculture. Lime to be added based on soil tests.

1.04 SEED:

A. All seed shall conform to all State Laws and to all requirements and regulations of the Georgia Department of Agriculture.

B. The several varieties of seed shall be individually packaged or bagged, and tagged to show name of seed, net weight, origin, germination, lot number, and other information required by the Department of Agriculture.

C. The Engineer reserves the right to test, reject, or accept all seed before seeding.

D. Mixtures of different types of seed called for in the seeding schedule shall be weighted and mixed in the proper proportions at the site of the work in the presence of the Engineer.

1.05 SEEDING SCHEDULE:

A. Hulled Bermuda Seeds are to be used at a rate of 40 pounds per acre, and at a depth of 1/4 to 1/8 inch. Pure line seed to be 82% by weight, with a maximum weed seed of 0.50%.

B. In shaded areas, or other areas as directed by the Owner or Engineer, the Contractor shall use a mixture of hulled Bermuda seed at a rate of 25 pounds per acre and carpet seed at a rate of 30 pounds per acre.

C. Temporary grassing shall consist of annual rye grass seed at a rate of 75 pounds per acre.

D. In areas where existing grasses are to be matched, the Contractor shall sow the seed at the rate recommended by the seed distributor.

1.06 STRAW MULCH:

A. Straw mulch material shall consist of straw or hay. Straw shall be stalks of wheat, rye, barley, oats, or other accepted straw. Hay shall consist of timothy, peavine, alfalfa, coastal bermuda or other grasses from accepted sources. These materials shall be reasonably dry and shall be reasonably free from mature seed-bearing stalks, roots, or bulblets or Johnson Grass, Nutgrass, Sandbur, Wild Garlic, Wild Onion, Wild Mustard, Crotolaria, Pigweed, Witchweed and Coclebur. The Contractor shall also comply with all State and Federal domestic plant quarantine regulations.

1.07 EXCELSIOR MULCH:

A. Excelsior mulch shall consist of wood fibers cut from sound, green timber. The average length of the fibers shall be 4 to 6 inches. The cut shall be made in such a manner as to provide maximum strength of fiber, but at a slight angle to the natural grain of the wood so as to cause splintering of the fibers when weathering in order to provide adherence to each other and to the soil.

1.08 WOOD CELLULOSE FIBER MULCH:

A. Wood cellulose fiber mulch shall be made from wood chips particles manufactured particularly for discharging uniformly on the ground surface when dispersed by a hydraulic water sprayer. It shall remain in uniform suspension in water under agitation and blend with grass seed and fertilizer to form a homogenous slurry. The mulch fibers shall intertwine physically to form a strong moisture holding mat on the ground surface and allow rainfall to percolate the underlying soil. The mulch shall be heat processed so as to contain no germination or growth-inhibiting factors. It shall be dyed (non-toxic) an appropriate color to facilitate metering of material.

B. Suppliers shall be prepared to certify that laboratory and field testing of their project has been accomplished, and that it meets all of the foregoing requirements based upon such testing.

C. Weight specifications for this material from suppliers and for all applications shall refer only to air dry weight of fiber material. Absolute air dry weight is

based on the normal weight standard of the Technical Association of the Pulp and Paper Industry for wood cellulose and is considered equivalent to 10% moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content.

1.09 SOD:

A. Sod shall be densely rooted, good quality centipede grass, free from noxious weeds. The sod shall be obtained from areas where the soil is reasonably fertile. The sod shall be raked free of all debris and the grass mowed to two inches before cutting. The sod shall contain practically all of the dense root system and not be less than one (1) inch thick. Sod shall be cut in uniform strips not less than twelve (12) inches in width and not less than twenty-four (24) inches in length.

1.10 PRODUCT REVIEW:

A. The Contractor shall provide the Engineer with a complete description of all products before ordering. The Engineer will review all products before they are ordered.

PART 2 - EXECUTION

2.01 STAND OF GRASS:

A. Before acceptance of the seeding performed for the establishment of permanent vegetation, the Contractor will be required to produce a satisfactory stand of perennial grass whose root system shall be developed sufficiently to survive dry periods and the winter weather and be capable of re-establishment in the spring.

B. Before acceptance of the seeding performed for the establishment of temporary vegetation, the Contractor will be required to produce a stand of grass sufficient to control erosion for a given area and length of time before the next phase of construction or the establishment of permanent vegetation is to commence.

2.02 SEEDING DATES AND RATES OF APPLICATION:

A. Seeding shall be performed during the periods and at the rates specified in the seeding schedules. Seeding work may, at the discretion of the Contractor, be performed throughout the year using the schedule prescribed for the given period. Seeding work shall not be conducted when the ground is frozen or excessively wet. The Contractor will be required to produce a satisfactory stand of grass regardless of the period of the year the work is performed.

2.03 PREPARATION:

A. The areas to be seeded or sodded shall be made smooth and uniform and shall conform with the finished grade and cross section shown on the plans or as otherwise designated. Minor shaping and smoothing of uneven and rough areas outside the graded section shall be performed as directed by the Engineer in order to provide for more effective erosion control and for ease of subsequent mowing operations.

B. The areas to be grassed, if not loose, shall be loosened to a minimum depth of 3 inches before agricultural lime, fertilizer, seed or sod is applied. The areas to be seeded shall be cleared of stones larger than 2-1/2-inches, in any dimension, roots, and other debris.

2.04 APPLYING LIME AND FERTILIZER:

A. Following advance preparation and placing selected material for shoulders and slopes when called for in the contract, lime if called for based on soil tests and fertilizer shall be spread uniformly over the designated areas and shall be thoroughly mixed with the soil to a depth of approximately 2 inches. Fertilizer shall be applied at the rate of 500 pounds per acre for the initial application, unless otherwise directed by the Engineer. Lime shall be applied at the rate determined by the soil test. Unless otherwise provided, lime will not be applied for temporary seeding. In all cases where practicable, acceptable mechanical spreaders shall be used for spreading fertilizer. On steep slopes subject to slides and inaccessible to power equipment, the slopes shall be adequately scarified. Fertilizer may be applied on steep slopes by hydraulic methods as a mixture of fertilizer and seed. When fertilizer is applied in combination seed and fertilizer drills, no further incorporation will be necessary. The fertilizer and seed shall be applied together when the method of seeding (Wood Cellulose Fiber Mulch) is used. Any stones larger than 2-1/2 inches in any dimension, larger clods, roots, or other debris brought to the surface shall be removed.

2.05 SEEDING:

A. Seed shall be sown within 24 hours following the application of fertilizer and lime and preparation of the seedbed as specified in Section 2.04. Seed shall be uniformly sown at the rate specified by the use of acceptable mechanical seed drills. Rotary hand seeders, power sprayers or other satisfactory equipment may be used on steep slopes or on other areas that are inaccessible to seed drills.

B. The seeds shall be covered and lightly compacted by means of a cultipacker or light roller if the drill does not perform this operation. On slopes inaccessible to

compaction equipment, the seed shall be covered by dragging spiked chains, by light harrowing or by other satisfactory methods.

C. Apply water with fine spray immediately after each area has been sown.

D. Do not sow seed when ground is too dry, during windy periods or immediately following a rain.

E. All seeded areas seeded with permanent grasses shall be uniformly mulched in a continuous blanket immediately following seeding and compacting operations, using at least 2 tons of straw per acre.

2.06 SEEDING (EXCELSIOR MULCH):

A. Seed shall be sown as specified in Section 2.05. Within 24 hours after the covering of seed, excelsior mulch shall be uniformly applied at the rate of 2 tons per acre. The mulch may be applied hydraulically or by other acceptable methods. Should the mulch be placed in a dry condition, it shall be thoroughly wetted immediately after placing. The Engineer may require light rolling of the mulch to form a tight mat.

2.07 SEEDING (WOOD CELLULOSE FIBER MULCH):

A. After the lime has been applied and ground prepared as specified in Section 2.04, wood cellulose fiber mulch shall be applied at the rate of 1,500 pounds per acre in a mixture of seed and fertilizer. Hydraulic equipment shall be used for the application of fertilizer, seed and slurry of the prepared wood pulp. This equipment shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry of the specified amount of fiber, fertilizer, seed and water. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles which will provide an even distribution of the slurry on the various areas to be seeded. The slurry tank shall have a minimum capacity of 1,000 gallons.

The seed, fertilizer, wood pulp mulch, and water shall all be combined into the slurry tank for distribution of all ingredients in one operation by the hydraulic seeding method specified herein. The materials shall be combined in a manner recommended by the manufacturer. The slurry mixture shall be so regulated that the amounts and rates of application shall result in a uniform application of all materials at rates not less than the amount specified. Using the color of the wood pulp as a guide, the equipment operator shall spray the prepared seedbed

with a uniform visible coat. The slurry shall be applied in a sweeping motion, in an arched stream so as to fall like rain, allowing the wood fibers to build upon each other until an even coat is achieved.

2.08 SODDING:

A. Sod shall be placed between March 1st and December 1st.

B. Sod shall be placed within 48 hours of cutting.

C. Sod shall be moist when laid and placed on moist ground. The sod shall be carefully placed by hand, beginning at the toe of slopes and working upwards. The length of the strips shall be at right angles to the flow of surface water. All joints shall be tightly butted and end joints shall be staggered at least 12 inches. The sod shall be immediately pressed firmly into the ground by tamping or rolling. Fill all joints between strips with fine screened soil. Sod on slopes shall be pegged with sod pegs to prevent movement. The sod shall be watered, mowed, weeded, repaired or otherwise maintained, to insure the establishment of a uniform healthy stand of grass until acceptance.

2.09 MAINTENANCE:

A. Maintain seeded and sodded surfaces until final acceptance.

B. Maintenance shall consist of providing protection against traffic, watering to ensure uniform seed germination and to keep surface of soil damp, and repairing any areas damaged as a result of construction operations or erosion.

2.10 ACCEPTANCE:

A. Before release of the performance bond on the seeding and sodding performed for the establishment of permanent vegetation, the Contractor will be required to produce a satisfactory stand of perennial grass whose root system shall be developed sufficiently to survive dry periods and the winter weather and be capable of reestablishment in the spring.

END OF SECTION

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SECTION 02512GA – ASPHALTIC CONCRETE BINDER/SURFACE COURSES

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SECTION 02512GA

ASPHALTIC CONCRETE BINDER/SURFACE COURSES

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Surface Course

B. Binder Course

1.2 RELATED SECTIONS

A. Section 01700 – Measurement and Payment

B. Section 02200 – Earthwork

C. Section 02231 – Aggregate Base Course

1.3 OMITTED

1.4 REFERENCES (LATEST REVISION)

A. ASTM D 946 – Penetration–Graded Asphalt–Cement for Use in Pavement Construction.

B. ASTM E 329 – Agencies Engaged in Construction Inspection and/or Testing.

C. ASTM D 3740 – Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock Used in Engineering Design and Construction.

D. ASTM D 2726 – Bulk Specific Gravity and Density of Non–Absorptive Compacted Bituminous Mixtures.

E. ASTM D 2950 – Density of Bituminous Concrete in Place by Nuclear Methods.

F. ASTM D 1754 – Effect of Heat and Air on Asphalt Materials (Thin–film Oven Test).

G. ASTM D 1188 – Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, 2013 Edition.

B. Mixing Plant: Conform to Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, 2013 Edition.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Do not place asphalt mixture when ambient air temperature is less than that indicated in the Table nor when the surface is wet or frozen.

Lift Thickness	Min. Air Temperature, Degrees F.
1" or Less	55
1.1" to 2"	45
2.1" to 3"	35
3.1" to 4"	30
4.1" to 8"	Contractor's Discretion

B. Mixture shall be delivered to the spreader at a temperature between 250 degrees F and 325 degrees F.

1.7 GUARANTEE

A. Contractor shall guarantee the quality of materials and workmanship for a period of 12 months after acceptance. Defects discovered during this period shall be repaired by the Contractor at no cost to the Owner.

1.8 TESTING

A. Testing laboratory shall operate in accordance with ASTM D 3740 and E 329 and be acceptable to the Engineer.

B. Testing laboratory and Project Engineer/Project Representative shall be given a minimum of 48 hours notice prior to taking any tests.

C. Testing shall be Contractor's responsibility and performed at Contractor's expense by a commercial testing laboratory operating in accordance with subparagraph A above.

D. Test results shall be furnished to the Engineer prior to continuing with associated or subsequent work.

PART 2 – PRODUCTS

2.1 TACK COAT

A. Material: Shall be PG67–22, asphalt cement, conforming to Sections 413 and 820 of the Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, 2013 Edition. When the temperature in the shade exceeds 70 degrees F, an emulsion such as CRS – 2h or CRS – 3 may be used.

2.2 ASPHALT CEMENT AND ADDITIVES

A. Asphalt Cement: Shall conform to the requirements of Section 820 of the Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, 2013 Edition. The material shall be PG67–22.

B. Anti–Stripping: Shall conform to requirements of Section 831 of the Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, 2013 Edition.

2.3 AGGREGATES

A. General: Mineral aggregate shall be composed of fine aggregate or a combination of fine and coarse aggregate. Coarse aggregate shall be the portion of material retained on a No. 8 sieve.

B. Fine aggregate shall be considered the portion passing a No. 8 sieve. Fine aggregate, coarse aggregate, and any additives in combination with the specified percentage of asphalt cement shall meet the requirements of tests specified, before approval may be given for their individual use.

C. Fine Aggregate: Shall conform to the requirements of Section 802 of the Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, 2013 Edition.

D. Coarse Aggregate: Shall be granite stone and conform to the requirements of Section 802.02 of the Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, 2013 Edition.

E. Surface Course: Shall consist of fine and coarse aggregate and mineral filler uniformly mixed with hot asphalt cement in an acceptable mixing plant. Job mix formula and design limits shall conform to 12.5 mm Superpave requirements (minimum 1.5 – inches).

F. Intermediate or Binder Course: Shall consist of fine and coarse aggregate and mineral filler uniform mixing with hot asphalt cement in an acceptable mixing plant. Job mix formula and design limits shall conform to 19 mm Superpave requirements (minimum 3–inches).

2.4 SOURCE QUALITY CONTROL AND TESTS

A. Submit proposed mix design for review prior to beginning of work.

B. Test samples in accordance with the requirements of these specifications.

PART 3 – EXECUTION

3.1 EXAMINATION

A. ON–SITE OBSERVATIONS: Owner's Representative or Engineer will have the right to require any portion of work be completed in their presence. If work is covered up after such instruction, it shall be exposed by the Contractor for observation at no additional cost to Owner. However, if Contractor notifies Engineer such work is scheduled, and Engineer fails to appear within 48 hours, the Contractor may proceed. All work completed and materials furnished shall be subject to review by the Engineer or Project Representative. Improper work shall be reconstructed.

All materials, which do not conform to requirements of specifications, shall be removed from the work upon notice being received from Engineer for rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

Contractor shall give the Owner, Project Engineer or Project Representative a minimum of 48 hours notice for all required observations or tests.

B. Contractor shall verify base has been tested, is dry, and gradients and elevations are correct.

3.2 PREPARATION

A. Apply tack coat in accordance with Section 413 of the Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, 2013 Edition. Rate of application shall be 0.04 to 0.06 gallons per square yard of surface.

B. Work shall be planned so no more tack coat than is necessary for the day's operation is placed on the surface. All traffic not essential to the work should be kept off the tack coat.

C. Apply tack coat to contact surfaces of curbs and gutters. Apply in manner so exposed curb or gutter surfaces are not stained.

D. Coat surfaces of manhole frames and inlet frames with oil to prevent bond with asphalt pavement. Do <u>not</u> tack coat these surfaces.

3.3 PLACEMENT

A. Construction shall be in accordance with Section 400 of the Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, 2013 Edition

B. Asphaltic concrete shall not be placed on a wet or frozen surface.

C. Compaction shall commence as soon as possible after the mixture has been spread to the desired thickness. Compaction shall be continuous and uniform over the entire surface. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks. Compaction rolling shall be complete before material temperature drops below 185° F.

D. Areas of pavement with deficient thickness or density shall be removed and replaced at no additional cost to the Owner.

3.4 TOLERANCES

A. General: All paving shall be subject to visual and straightedge evaluation during construction operations and thereafter prior to final acceptance. A 10 foot straightedge shall be maintained in the vicinity of the paving operation at all times for the purpose of measuring surface irregularities on all paving courses. The

straightedge and labor for its use shall be provided by the Contractor. The surface of all courses shall be checked with the straightedge as necessary to detect surface irregularities. Irregularities such as rippling, tearing or pulling, which in the judgment of the Engineer indicate a continuing problem in equipment, mixture or operating technique, will not be permitted to recur. The paving operation shall be stopped until appropriate steps are taken by the Contractor to correct the problem.

B. Flatness: All irregularities in excess of 1/8 inch in 10 feet for surface courses and 3/16 inch in 10 feet for intermediate and base courses shall be corrected.

1. General Paving: Less than 1/4 inch.

2. Accessible Routes: Shall not exceed 1/4 inch. However, accessible routes shall not exceed maximum ADA allowable slopes. Contractor shall remove and replace any and all portions of the accessible route that exceed maximum ADA allowable slopes.

3. Variation from Design Elevation: Less than 1/4 inch.

4. Scheduled Compacted Thickness: Less than 1/4 inch under tolerance.

5. Pavement Deficient in Thickness: When measurement of any core indicates the pavement is deficient in thickness, additional cores will be drilled 10 feet either side of the deficient core along the centerline of the lane until the cores indicate the thickness conforms to the above specified requirements. A core indicating thickness deficiencies is considered a failed test. Pavement deficient in thickness shall be removed and replaced with the appropriate thickness of materials. If the Contractor believes the cores and measurements taken are not sufficient to indicate fairly the actual thickness of the pavement, additional cores and measurements will be taken, provided the Contractor will bear the extra cost of drilling the cores and filling the holes in the roadway as directed.

3.5 FIELD QUALITY CONTROL

A. Acceptance of the in–place density of the surface course shall be in accordance with the Georgia Department of Transportation Standard Specifications Construction of Transportation Systems, 2013 Edition and these specifications.

B. Density Testing: Performed in accordance with ASTM D–2726 and ASTM D–2950. Core samples for each day's operation shall be taken, tested and results reported to the Engineer the following day. The areas sampled shall be properly restored by the Contractor at no additional cost to the Owner. Nuclear gauge tests shall be taken during the asphaltic concrete placement.

1. The pavement core and nuclear gauge densities shall range between 92% and 96% of the theoretical maximum density.

C. Temperature:

1. Asphaltic concrete shall not exceed 325 degrees F at any time.

2. Asphaltic concrete shall not be placed once the temperature of the mix falls below 250 degrees F or the delivered temperature is more than 15 degrees F below the batch plant's delivery ticket.

3. Temperature at time of loading shall be recorded on the truck delivery ticket.

D. Frequency of Tests:

1. Asphaltic Concrete – One test for each 250 tons placed.

   a. Asphalt extraction and gradation test.

   b. Core Sample

2. Field determination of density by nuclear method every 5,000 square feet during construction of the asphaltic concrete binder/surface course.

END OF SECTION

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SECTION 02550

WATER DISTRIBUTION SYSTEM

PART 1 - PRODUCTS

Products and materials used in the work shall conform to the following:

1.01 PIPE

A. Ductile Iron Pipe - Shall conform to ANSI/AWWA C150/A21.50 latest revision and ANSI/AWWA C151/A21.51 latest revision for laying condition two. All pipes shall be cement lined in accordance with ANSI/AWWA C104/A21.4 latest revision.

B. P.V.C. Pipe - All P.V.C. pipe shall bear the seal of the National Sanitation Foundation. All waterline pipes shall be blue in color. Certificates of conformance with the following specifications shall be furnished with each lot of pipe supplied.

Pipe 4-inches through 12-inches shall conform to all requirements of ANSI/AWWA C900, latest revision, and shall be DR-18 with a minimum pressure rating of 150 psi.

Pipe larger than 12-inches shall conform to all requirements of ANSI/AWWA C905, latest revision, and shall be DR-18 with a minimum pressure rating of 150 psi.

C. Tubing - Tubing shall conform to the following:

1. Polyethylene – 1-inch polyethylene tubing shall conform to all requirements of ASTM D1248, grade P34, Class C; ASTM D2737, PE3408: ASTM D3350, cell class 335424C; and AWWA C901. The tubing shall be pressure class 200 with SDR 9. Marking of the tubing shall include: nominal pipe size, PE 3408, SDR 9, PC 200, AWWA C901, Manufacturers name and seal or mark of testing agency certifying suitability of the pipe material for potable water products as per AWWA C901 Section 6.1.2.

   2" water service line shall be polyethylene conforming to AWWA C901.88/ASTM D-1248, ASTM D-2239, ASTM D-2737, ASTM D-3035. No 1.5", 2.5" or 3" will be allowed.

2. Copper Tubing – One (1) inch and two (2) inch Copper tubing shall be seamless and shall conform to ANSI/AWWA C800 and ASTM B88, Type K, containing not less than 99.90% copper and not more than 0.04% phosphorus, suitable for use with a working pressure of 150 psi. No 1.5", 2.5", or 3" will be allowed.

3. All water service tubing two (2) inches and smaller shall be copper tube size (cts).

1.02 JOINTS

A. Flanged Joints - Shall conform to ANSI/AWWA C115/A21.15 latest revision. Bolts shall conform to ANSI B18.2.1 and nuts shall conform to ANSI B18.2.2. Gaskets shall be rubber, either ring or full face, and shall be 1/8-inch thick. Gaskets shall conform to the dimensions recommended by ANSI/AWWA C115/A21.15 latest revision. Flanged joints shall not be used for buried installations.

B. Mechanical Joints - In ductile iron pipe shall conform to ANSI/AWWA C111/A21.11 latest revision.

C. Push-On Joints - In ductile iron pipe shall conform to ANSI/AWWA C111/A21.11 latest revision.

D. Fluorinated Hydrocarbon Gaskets - Fluorinated hydrocarbon gaskets for ductile iron pipe shall conform to the requirements of ANSI/AWWA C111/A21.11-90 (Trade names may include, but are not limited to "Fluoral" or "Viton") and shall be required where petroleum exposure may occur.

E. Plastic Pipe

1. Joints in plastic pipe four (4) inches and larger shall meet all requirements of ANSI/AWWA C900/C905 latest revision. The integral bell joint system (push-on joints) shall meet the requirements of ASTM D-3139 and utilize an elastomeric seal conforming to ASTM F-477.

2. Joints in one (1) inch and two (2) inch plastic tubing shall conform to ASTM D3139 latest revision. Solvent joints shall not be used. Compression joints with no lead brass are acceptable only for one (1) inch and two (2) inch pipes.

3. Butt-fused joints for FPVC pipe are acceptable when performed in accordance with manufacturers' guidelines.

F. Restrained Joints - Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to "Megalug" or push-on type joints equivalent to "Lock-Ring," "TR Flex", or "Super Lock" and shall have a minimum rated working pressure of 250 psi. Mechanical joint retainer glands shall comply with the manufacturer's specifications for the pipe material (ductile iron vs. PVC). The joints shall be in accordance with the applicable portions of ANSI/AWWA C111/A21.11. The manufacturer of the joints shall furnish certification, witnessed by an independent laboratory, that the joints furnished have been tested at a pressure of 500 psi without signs of leakage or failure. All wedge assemblies and related parts of restraint devices shall be processed through an iron-phosphate spray, rinse and drying operation in preparation for coating application. The coating shall consist of a minimum of two coats of liquid Xylan® fluoropolymer coating with heat cure to follow each coat. All casting bodies of restrained joints shall be surface pretreated with an iron-phosphate spray, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. The coating shall be a polyester based powder to provide corrosion, impact and UV resistance. The coating system shall be Mega-Bond™ by EBAA Iron, or approved equal. Restrained joints shall be capable of being deflected after assembly. Restrained joints shall have a preset deflection of no more than 5° and shall be able to take up 3° of deflection after burial.

1.03 FITTINGS

A. Fittings for Ductile Iron or Plastic Pipe - Shall be compact ductile iron, manufactured in accordance with ANSI/AWWA C153/A21.53 latest revision. They shall be cement lined in accordance with ANSI/AWWA C104/A21.4 latest revision. An asphaltic coating with a thickness of 1 mil shall be applied to all fittings. Fittings shall be designed to accommodate the type of pipe used.

B. Fittings for Flanged Pipe - Shall be manufactured in accordance with ANSI/AWWA C110/A21.10, latest revision and pressure rated at 150 psi.

C. Fittings for plastic tubing - Shall be low lead brass, compression type.

1.04 POLYETHYLENE ENCASEMENT

Polyethylene encasement shall be used on all ductile iron pipe and shall be in tube form conforming to the requirements of ANSI/AWWA C105/A21.5 latest revision. The polyethylene film shall have the following characteristics:

Tensile Strength:	1,200 psi minimum
Elongation:	300 percent minimum
Dielectric Strength:	800V/mil thickness minimum
Thickness:	Nominal thickness of 0.008 inch (8 mil)

1.05 CAUTION TAPE

Caution tape shall consist of a minimum 4.0 mil thickness inert polyethylene plastic that is resistant to alkalis, acids and other destructive elements found in the soil. The tape shall have a minimum three (3) inch width and a minimum tensile strength of 2,800 psi. A continuous warning message repeated every 16 to 36-inches shall be imprinted on the tape surface. The tape shall contain an opaque color concentrate designating the color code appropriate to the line being buried (Water Systems - Safety Precaution Blue with "Caution - Buried Water Line Below" imprinted in black). Caution tape shall be installed 24-inches above the pipe on all water mains

1.06 TRACER WIRE AND CONNECTORS

A. Tracer Wire

Tracer wire shall be installed on all water mains and service laterals from the main to the meter, with direct burial connectors, and provide continuous electrified conductivity. Area markers shall be at least every 500 feet with tracer wire attached, unless a manhole or fire hydrant is available. A six (6) foot lead attached to the inside of the ring and cover shall be provided at manholes. On laterals, the tracer wire shall terminate inside the meter box.

1. Tracer wire shall be copper clad steel with high-density, high molecular weight polyethylene (HDPE) insulation, and rated for direct burial use at 30 volts. Conductor must meet 21% conductivity for locate ability purposes. HDPE insulation shall be RoHS compliant and utilize virgin grade material. Insulation color shall meet the APWA color code standard for identification of buried utilities.

2. Tracer wire for direct burial shall be a #12 AWG HS-CCS high-strength copper clad steel conductor (HS-CCS), insulated with a 30 mil, HDPE insulation. Minimum break load shall be 380 lbs. Wire must be installed in the 3 o'clock position during installation. Tracer wire shall be Boar Tough High Strength CCS PE30 UL by Agave Wire Ltd or Copperhead HS-CCS HDPE 30 MIL or Pre-Approved Equal.

3. Tracer wire for directional drilling/boring shall be #12 AWG extra-high-strength copper clad steel conductor (EHS-CCS), insulated with a 45 mil, HDPE insulation. Minimum break load shall be 1,150 lbs. Tracer wire shall be Boar Tough Extra High Strength by Agave Wire Ltd, Copperhead EHS-CCS HDPE 45 MIL or Pre-Approved Equal.

B. Connectors

1. Wire connectors shall be UL 486D listed, one-piece direct bury twist-on type, UL designation MDB, sealed wire connectors. Max voltage shall be 600 Volts. Connectors shall be rated to 105° C and sized to accommodate a minimum of four (4) #12 copper / steel core tracer wires. Silicone sealant shall be rated for temperatures from -45° F to 400° F. Connector shall be DryConn King 6 Blue by King Innovation, or pre-approved equal.

2. Spliced connectors shall be direct bury design, with a maximum voltage of 50-volts. Spliced connectors shall have a tin plated high conductivity aluminum lug, zinc-plated steel screws, high-impact polypropylene housing, and a non-hardening viscous dielectric silicone sealant. Silicone sealant shall be rated for temperatures from -45° F to 400° F. Spliced connector shall be DryConn Direct Bury Lug Aqua, or pre-approved equal.

C. Area Markers - Utility marker posts equal to Rhino TriView Plus Test Station shall be installed every 500-foot along water mains. Posts shall be marked as "Water Pipeline".

1.07 CASING AND CASING SPACERS

A. Casing pipe shall be steel conforming to ASTM A139, latest revision, minimum yield point of 35,000 psi, and of the diameter and thickness shown on the contract drawings at each crossing. The pipe ends shall be tapered where welding is required. Full pipe lengths shall be provided. No pipe casing lengths less than eight (8) feet shall be allowed unless approved by the Owner. All casing welds shall be continuous and made by a certified welder.

For casing pipe crossings under roadways/railroads, the Contractor shall comply with the regulations of said authority in regard to design, specifications, and construction. State highway casing installations shall be as specified in the GDOT, "Utility Accommodation Manual," and for railroads, the American Railway Engineering and Maintenance-of-Way Association (AREMA) manual for Railway Engineering, Chapter 1,

Part 5, Section 5.3, "Specifications for Pipelines Conveying Non-Flammable Substances," shall be applicable.

Where allowed by the affected utility owner(s), fusible PVC casing may be used with fusible PVC carrier pipe. The design engineer shall calculate the appropriate piping dimension ratio (DR) for fusible PVC casing considering earth, live, and groundwater, service loads and pullback forces.

Use of PVC casing shall require the use of rubber boots for end seals. End seals shall be neoprene with 304 SS banding clamps as manufactured by Cascade CCES, or approved equal. End seals shall be installed per manufacturer's recommendations, to include casing spacer spacing to provide adequate reinforcement at end of casing pipe.

All carrier pipes shall be restrained joint ductile iron or fusible PVC.

B. Casing Spacers shall be bolt on style with a shell made in two (2) sections of Heavy T-304 Stainless Steel. Connecting flanges shall be ribbed for extra strength. The shell shall be lined with a PVC liner. All nuts and bolts shall be 18-8 Stainless Steel. Runners shall be made of Ultra High Molecular Weight Polymer with inherently high abrasion resistance and a low coefficient of friction. Runners shall be supported by risers made of Heavy T-304 Stainless Steel. The combined height of the supports and runners shall keep the carrier pipe a minimum of 0.75" from the casing pipe at all times. Installation and spacing of casing spacers shall be as required by the manufacturer. Casing spacers shall be as manufactured by Cascade Waterworks Manufacturing Company, or approved equal.

   Casing spacers for fusible PVC carrier pipe should be of a projection type that has a minimum number of projections around the circumference that total the number of diameter inches. For example: 8" pipe should have a minimum of 8 projections and 18" pipe should have a minimum of 18 projections. Spacing between spacer rings (span) should be calculated based on the actual installed load (weight of pipe filled with liquid) but should not exceed 10 feet. Refer to the manufacturer's tables for the load carrying capacity of each type of spacer used. Casing spacers should be projection type – non metallic spacers constructed of preformed sections of high-density polyethylene. Spacers should be ISO 9001:2000 certified for strength and quality. Casing spacers should be installed using double backed tape provided with the spacers in order to fasten them tightly to the carrier pipe. Casing spacers for fusible PVC carrier pipe shall be as manufactured by Raci North America, or approved equal.

1.08 VALVE MANHOLES

A. Manholes shall be precast concrete, unless authorized by the Water Department. Manhole diameter shall be large enough to allow an eighteen (18) inch clearance between any bolts necessary for valve / actuator removal or in-situ maintenance or repair, and the manhole inner wall.

B. Brick manholes shall be new whole brick of good quality laid in cement mortar. The bottom of the manhole shall be concrete. Brick manholes shall only be allowed where precast manholes cannot be used.

1. Concrete - Concrete shall have a compressive strength of 3,000 psi in 28 days. Concrete shall be ready-mixed conforming to ASTM C904. Reinforcing steel shall conform to ASTM C615, Grade 60. Mesh reinforcing shall conform to ASTM A185. Concrete covering deposited directly against the ground shall have a minimum thickness of three (3) inches between the reinforcing and the ground.

2. Mortar - Mortar shall be composed of one part by volume of Portland cement and two parts of sand. The Portland cement shall conform to ASTM C160, Type I. The sand shall conform to AASHTO Standard A45 and shall be of an acceptable gradation. The quantity of water in the mixture shall be sufficient to produce a workable mortar, but in no case exceed 7 gallons of water per sack of cement. Water for mixing shall be potable water, clean and free of harmful acids, alkalies and organic impurities. The mortar shall be used within 30 minutes from the time the ingredients are mixed with water.

3. Brick Masonry - Brick shall conform to ASTM C62, Grade SW or C-55, Grade P-I or P-II. The joints shall be completely filled with mortar and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with ½-inch of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course, and for round structures, brick shall be laid radially with every sixth course a stretcher course.

C. Precast concrete manholes with four (4) feet internal diameter shall be used for lines 8" in diameter or less and have a minimum wall thickness of five (5) inches. Precast concrete manholes with six (6) feet internal diameter shall be used for lines 10" in diameter or more and have a minimum wall thickness of seven (7) inches. Manholes shall be manufactured with 4,000 P.S.I. concrete, type II cement. Wall reinforcement

shall meet ASTM-478 and also have a No. 4 rebar hoop around each pipe opening. Top slabs shall be six (6) inches thick and be reinforced with No. 6 rebar at 6" O.C.E.W. Bottom slabs shall be six (6) inches thick and be reinforced with No. 4 rebar at 9" O.C.E.W. All items shall be wet cast. Dry casting or low slump concrete will not be allowed. All bases will have proper lifting hooks in the bottom slabs (min. of 3) and there shall be no penetrating lifting holes on any structures. No holes will be allowed within six (6) inches of any joint on structures.

It shall be the responsibility of the Contractor to ensure that the manhole(s) are designed properly for the loading conditions as indicated on the plans. Should the loading conditions require greater structural integrity than the minimum, as herein specified, it shall be the responsibility of the Contractor to utilize a design with greater strength.

Gaskets shall be O-Ring or Type A or B "Tylox," or equivalent, conforming to ASTM C-443; Mastic shall be "Ram-nek," or equivalent, with primer. The primer shall be applied to all contact surfaces of the manhole joint at the factory in accordance with the manufacturer's instructions.

D. Ring and Cover - Manhole ring and cover shall be gray cast iron per ASTM A48, Class 35B without perforations and suitable for addition of cast iron or steel rings for upward adjustment of top. The words "CITY OF SAVANNAH WATER GEORGIA" shall be cast into the face of the cover in 1.5-inch to 2-inch letters raised flush with the top of the cover. Ring and cover shall have machine ground seats and be an approved equal to model V1327-1 RG V1327GS EPIC SAVANNAH SN as manufactured by E.J. All manhole rings and covers shall be made water resistant by means of dovetail grooves and gaskets in the cover. Provide circular cover with two (2) pick slots for removing cover spaced at 180° and weighing not less than 138 pounds. No stacking lugs shall be allowed.

Proof Load Testing - Traffic service castings shall have a first article proof load test conducted and the results of that proof load test shall be made available to the City upon request. The proof load test shall be conducted in accordance with the methods and procedures outlined in AASHTO M306-10, Section 6, Proof Load Testing. The casting shall be tested on a suitable and calibrated load testing machine and the casting shall hold a 40,000 pound proof load for one minute without experiencing any cracks or detrimental permanent deformation.

E. Manhole Steps – Manhole steps shall be provided at 16-inches O.C. for manholes greater than five (5) feet deep. Steps shall have impact resistant co-polymer

polypropylene plastic molded around ½" diameter, grade 60 reinforcing steel. Manhole steps shall be M.A. Industries PS1-PF reinforced plastic step complying with the requirements of ASTM C 478, or approved equal.

F. Final Grade - Manholes in roads, streets, or highways shall be built to the pavement grade, the grade designated on the plans, or as directed by the Engineer. Tops of manholes outside of roads, streets, and highways shall be flush with the finished ground surface unless otherwise shown on the plans. Manholes shall not be located in areas where ponding or the collection of surface water may occur.

1.09 GATE VALVES

A. Valves shall conform to the latest revision of AWWA Standard C515 covering resilient seated gate valves for water supply service. Valves shall be as manufactured by the Clow Valve Company, or approved equal.

B. The valves shall have a ductile iron body, bonnet, and O-ring plate. The wedge shall be totally encapsulated with rubber.

C. The sealing rubber shall be permanently bonded to the wedge per ASTM D429.

D. Valves shall be supplied with O-ring seals at all pressure retaining joints.

E. The valves shall be non-rising stem, opening by turning left or right, and provided with 2" square operating nut with the word "Open" and an arrow to indicate the direction to open.

F. Stems shall be cast copper alloy with integral collars in full compliance with AWWA. All stems shall operate with copper alloy stem nuts independent of wedge and of stem. Stems shall have two O-rings located above thrust collar and one O-ring below. Stem O-rings shall be replaceable with valve fully opened and subjected to full pressure. The stems on 4" – 20" shall also have two low torque thrust bearings located above and below the stem collar to reduce friction during operation.

G. Waterway shall be smooth, unobstructed and free of all pockets, cavities and depressions in the seat area. Valves 4" and larger shall accept a full size tapping cutter.

H. The body, bonnet and O-ring plate shall be fusion-bond epoxy coated, both interior and exterior on body and bonnet. Epoxy shall be applied in accordance with AWWA C550 and be NSF 61 Certified.

I. Bolts, studs, and nuts shall be made of 304 stainless-steel. Stainless steel bolts and studs shall not be used on stainless nuts unless the threads are coated with an anti-seize compound.

J. Each valve shall have maker's name, pressure rating, and year in which it was manufactured cast in the body. Prior to shipment from the factory, each valve shall be tested by hydrostatic pressure equal to the requirements of AWWA C515 (and UL/FM where applicable). Gate valves shall be installed in a manhole per Details W-25A, B, C, or D.

1.10 BUTTERFLY VALVES

A. All butterfly valves shall be of the rubber-seated, tight-closing type. They shall meet or exceed AWWA standard C504, latest edition, Class 150. Butterfly valves shall not be used on pipe smaller than 14-inches unless, otherwise specified, and shall be installed in a manhole per Detail W-26. All valves shall be M&H 4500/1450 butterfly valves, or approved equal.

B. Both ends shall be flanged per ANSI B16.1 (or as otherwise noted on plans and specs).

C. Valve shafts shall be ASTM A276 Type 304 stainless steel. Valve shafts shall have a minimum diameter extending through the valve bearings and into the valve disc as specified in AWWA C504. All valve shafts must meet or exceed the minimum connection torque requirement set forth in AWWA C504.

D. Valve body and vane shall be high-strength cast iron to ASTM A126, Class B or high-strength ductile iron to ASTM A536 with ASTM A276 Type 304 stainless steel body seats. For valves 18" and larger, valve body and vane shall be of high-strength ductile iron to ASTM A536, Grade 70-50-05 with ASTM A276 Type 304 stainless steel body seat.

E. Rubber valve seats shall be a full-circle 360 degree, seat not penetrated by the valve shaft. Valve seat shall be EPDM for cold or high water temperature applications. The valve seat will be attached to the valve vane by 18-8 Type 304 stainless steel self-locking fasteners. The valve seat must be easily field adjustable and replaceable without any special tools or lengthy curing time.

F. Valve shaft seals shall be of the O-ring type and utilize the same elastomer as specified for the valve seats and for the intended service. All valve shaft seals must be easily field replaceable.

G. Valve actuator shall be of the traveling nut type, sealed and lubricated for underground or in-plant service. Operator shall be capable of withstanding an overload input torque of 450 ft-lbs. at full-open or full-closed position without damage to the valve operator. Operators must have a 304 stainless steel external stop limiting device and travel adjustment. The travel adjustments must be able to be operated without removing the valve from the line or removing the actuator cover. All valve actuators must be sized per AWWA C504. Certification of proof of design and torque requirements shall be submitted to the owner upon request.

H. The valve interior and exterior surfaces shall be coated in accordance with the latest revisions of AWWA C504 and must be NSF 61 Certified.

1.11 TAPPING VALVES

All tapping valves shall be provided with a standard flange on one end for bolting to the tapping sleeve. The outlet end shall be mechanical joint, flanged for bolting to a standard tapping machine. All tapping valves shall be resilient seat. No double disc shall be permitted. In all other respects, tapping valves shall comply with the requirements for gate valves.

1.12 TAPPING SLEEVES

Tapping Sleeves shall be compact ductile iron mechanical joint type conforming to ANSI/AWWA C153/A21.53 for fittings four (4) inches to 16-inches or ANSI/AWWA C110/A21.10 for fittings larger than 16-inches, latest revision. All tapping sleeves and valves shall be pressure tested prior to tapping. The tapping sleeve shall include the necessary pressure test port.

1.13 AIR RELEASE VALVE

A. General:

Air Release Valves (ARV's) shall be provided as required by the Engineer, who shall specify ARV type (or function), size, and location. The ARV's specified below are one-inch air release valves suitable for most water main applications and larger combination air and vacuum release valves suitable for water transmission mains.

The specification of these two (2) valves below does not relieve the Engineer of the responsibility to select and locate ARV's for proper main operation and long-term durability. ARV selection shall be in accordance with AWWA Manual of Water Supply

Practices M51 - Air-Release, Air/Vacuum & Combination Air Valves, the manufacturer's published information, and the Engineer's experience.

The manhole and installation of the one-inch air release valve shall be in accordance with the City of Savannah Standard Construction Detail W40. Prior to deciding on the location of any air release valve, the Contractor shall provide the Engineer with an accurate profile of the installed mains so that high points in the system can be determined. The locations of the valves shall be field adjusted based on the locations of the high points.

B. Small (1") Air Release Valves for Water Mains

Air release valves shall be designed to vent small amounts of air from the system while it is pressurized.

1. The valve(s) shall operate through a compound lever system and shall have a 1/4-inch orifice with valve sealing faces of an adjustable Buna-N rubber valve and PVC seat. It shall operate at 150 PSIG, and be capable of passing 98 SCFM of air.

3. The valve(s) shall be one-inch NPT screwed inlet connection and shall have a cast iron body and top, a stainless steel float and trim. Valves which use a needle to seal the orifice will not be acceptable.

4. The body and cover shall be cast iron conforming to ASTM 126, Class B and have a maximum operating pressure of 300 psi.

5. The valve(s) shall be Crispin Model PL10 Pressure Air Valve(s), Type N, as manufactured by Crispin-Multiplex Manufacturing Co., Berwick, PA.

6. A turn-down, or snorkel, shall be provided to prevent dirt and other debris from falling into the orifice while allowing the free discharge of air or water.

7. When submergence of the air release valve is possible, a Vacuum Check Valve shall be supplied on the outlet to eliminate the possibility of water (or air) from entering the system when the pressure decreases, or if a vacuum is drawn.

8. Corporation stops for air release valves shall be 1" Brass or Bronze with one (1) inch inlet and one (1) inch outlet outside iron pipe threads equivalent to Mueller Model #H-10013.

9. Tapping saddles for combination air release valves shall be equivalent to Smith-Blair No. 313-015.

C. Large (4") Combination Air Valves for Water Transmission Mains

Combination Air Valves shall be automatic float operated valves designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry. The valve shall open during draining or if a negative pressure occurs. The valve shall also release accumulated air from a piping system while the system is in operation and under pressure.

Valves shall be manufactured and tested in accordance with American Water Works Association (AWWA) Standard C512 and shall be certified to NSF/ANSI 61.

1. Connections - Air valves shall have full size NPT inlets and outlets equal to the nominal valve size. The valve shall have two additional NPT connections for the connection to gauges, testing, and draining.

2. Design - Valve shall provide a through flow area equal to the nominal size. Floats shall be unconditionally guaranteed against failure including pressure surges. The cover shall be bolted to the body and sealed with a flat gasket. A resilient bumper shall be provided to cushion the float during sudden opening conditions. The resilient seat shall be replaceable and provide drop tight shut off to the full valve pressure rating.

   Single body combination valves shall have an expanded outlet to provide full flow area around the guide mechanism. The valve shall have a double guided plug and an adjustable threaded orifice button. The plug shall be protected against direct water impact by an internal baffle. The plug shall have a precision orifice drilled through the center stem. A protective hood shall be provided to prevent debris from entering the valve.

   All air (Release, Vacuum, etc) valves installed in vaults or flood prone locations (where submergence of the valve is possible) shall include an inflow preventer to prevent the introduction of contaminated water through the air valve outlet. The inflow preventer shall allow the admittance and exhausting of air while preventing contaminated water from entering during normal operating conditions. The inflow preventer shall be flow tested by an independent third party testing lab, approved by the American Society of Sanitary Engineers, to certify performance.

3. Materials - The valve body and cover shall be constructed of ASTM A126 Class B cast iron. All wetted or internal parts shall be constructed of Type 316 stainless steel. Non-metallic floats, linkage, or bushings are not acceptable. Resilient seats shall be Buna-N.

4. Manufacture - Combination Air Release Valves shall be Series 204C.2 as manufactured by Val-Matic Valve and Manufacturing Corporation, Elmhurst, Il, USA or approved equal.

1.14 SMALL BALL VALVE

Ball Valves two (2) inch and smaller shall be designed for a working pressure of not less than 175 psi. End connection shall be threaded. The body and all parts shall be no lead brass in accordance with AWWA C800 and ASTM B62 latest revision. The ball shall be fluorocarbon coated brass with molded Nitrile (BUNA-N) seats sealed in place. All internal parts shall be permanently assembled by way of a metal to metal body joints with sealed threads.

1.15 VALVE BOXES

Valve Boxes - Underground two (2) inch valves and fire hydrant valves shall be installed in accepted valve boxes. The valve boxes shall be embedded in No. 57 stone wrapped with filter fabric, with shaft extension sections to cover and protect the valve and permit easy access and operation. The cover shall be cast iron and shall be marked "WATER". The box and any extensions needed shall be cast iron having a crushing strength of 1500 psi. The top section shall be the screw type, adjustable for elevation. When installed in paved areas or sidewalks, the top shall be set flush into the pavement or sidewalk. When installed in unpaved areas, a pre-cast concrete collar edge shall be set flush at finished grade level. Valve boxes and collars shall conform to the detail shown.

1.16 POST TYPE FIRE HYDRANTS

Post Type Fire Hydrants shall be equivalent to Mueller 2-1/8-inch Post Type Fire Hydrant, have one way main valve opening and one 2½-inch hose nozzle. All internal and external parts shall conform to Section 1.17 Fire Hydrants.

1.17 FIRE HYDRANTS

A. General - Hydrants shall be manufacturer's current model design and construction. All units are to be complete including joint assemblies. Physical characteristics and

compositions of various metal used in the hydrant components shall meet the requirements as specified in ANSI/AWWA C502 latest revision. Hydrant shall be suitable for working pressure of 150 psi and shall be hydrostatically factory tested to 300 psi.

B. Bonnet - Bonnet shall be of the dry reservoir type. Bonnet must have a lubricating fitting for ease of lubrication. All parts shall be removable through top of hydrant without removing entire barrel section from safety flange.

C. Nozzles and Caps - The hydrant shall have two (2) 2¼-inch connection and one (1) 4½-inch steamer connection, National standard threads. Nozzles shall be bronze and have interlocking lugs to prevent blowout. Nozzle caps shall not be equipped with chains.

D. Seat Ring - Seat ring shall be bronze to bronze. The bronze shall be Grade A, B, D, or E.

E. Drain Valves and Openings - Positive operating drain valves shall be provided to assure drainage of fire hydrant when the main valve is closed. Drain openings shall have bronze bushings.

F. Main Valve - Valve shall be designed to close with the pressure and remain closed. Valve shall be bronze Grade A, B, D, or E, that will resist rocks or other foreign matter. Valve shall have a full 4½-inch opening.

G. Barrel and Safety Flanges - Hydrant shall have a safety-type vertical barrel with a minimum approximate bury of 3½-foot and be designed with safety flange and/or bolts to protect the barrel and stem from damage and to eliminate flooding when hydrant is struck. Bury depth shall be cast on barrel of hydrant. All risers necessary for deeper bury applications shall be provided by the hydrant manufacturer. A maximum riser height of one (1) foot shall be allowed.

H. Operating Stop and Nut - Hydrant shall have a positive stop feature to permit opening of hydrant without over travel of stem. The operating stop shall be located at the bottom of the hydrant by means of a cap nut or stop nut at the end of the main valve stem. Operating nut shall be bronze, 1¼-inches, point to flat, pentagon.

I. Bolts and Nuts - Bolting materials shall develop the physical strength requirements of ASTM A307. Bolts, studs, washers and nuts shall be made from a corrosion-resistant material such as low zinc bronze, monel, stainless steel or low alloy steel conforming to ASTM A242.

J. Inlet - Bottom inlet of hydrant shall be provided with mechanical joint connection as

specified and shall be six (6) inch nominal diameter.

K. Direction of Opening - Hydrants shall be designed to close "right" or clockwise and open "left" or counter-clockwise.

L. Coatings - All inside portions of the hydrant shall be coated in accordance with ANSI/AWWA C550 latest revision. The exterior portion of hydrant above ground level shall be painted with two (2) coats of red primer paint equivalent to Hydrant Hide Red Setter #9050 as manufactured by Pennsbury Coatings Corporation. After the hydrant has been accepted and placed in service, the exterior, above-ground portion of the hydrant shall be painted with two (2) coats of yellow hydrant enamel equivalent to Hydrant Hide Old Yeller #9032 as manufactured by Pennsbury Coatings Corporation.

M. Joint Assemblies - Mechanical joint assemblies shall conform to ANSI/AWWA C111/A21.11 latest revision.

N. Inspection and Affidavit - Hydrants furnished under this specification shall be subject to inspection and acceptance by City personnel, and, if required, shall have full access to manufacturer's facilities for inspection and observation of tests. Manufacturer is also required to furnish the City with an affidavit of compliance with specifications covering all materials and test procedures relating to construction of the hydrants.

1.18 CORPORATION STOPS

Corporation stops shall be no lead brass composition and shall be manufactured in conformance with ANSI/AWWA C800 and ASTM B62. The key and body seating surfaces shall be accurately machined and fit to a taper of 1¾-inches per foot. The stem and retaining nut shall be so designed that failure from over-tightening of the retaining nut results in thread stripping rather than stem fracture. Corporation stops shall be equivalent to Mueller or Ford.

1.19 CURB STOPS

Curb stops shall be a one (1) inch no lead brass ball valve with a ball valve lock provided for each valve manufactured in conformance with ANSI/AWWA C800. The curb stop shall be closed bottom design and sealed against external leakage at the top by means of a non-adjustable resilient pressure actuated seal, and shall be provided with a secondary resilient seal disposed above the pressure seal for added protection of the bearing surfaces against ground water infiltration. Shut off shall be effected by a

resilient pressure actuated seal so disposed in the key as to completely enclose the inlet body port in the closed position. All ball valves shall be ¼ turn valves and the full open and closed position shall be controlled by check lugs which are integral parts of the key and body. The pressure rating shall be 175 psi. The ball valves shall be equivalent to Ford or Mueller or equal. Valves shall be full part, packed joint with one (1) inch diameter locking grip compression connection on the inlet side and one (1) inch diameter female iron pipe thread connection on the meter side.

1.20 TAPPING SADDLES

Tapping saddles shall be equivalent to Smith-Blair 313-015 with a one (1) inch AWWA tapped connection. All one (1) inch and two (2) inch taps on water lines smaller than six (6) inches will require a tapping saddle. Brass saddle shall be Ford 202B Brass Saddle or equal. No service taps shall be allowed on transmission mains larger than 12-inches unless approved by the City.

1.21 PERMANENT SAMPLING STATION

Sampling Stations shall be 36-inch minimum bury, with a 3/4-inch FIP Inlet and a 3/4-inch unthreaded nozzle. The station shall be enclosed in a lockable, non-removable, aluminum-cast housing. When opened, the station shall require no key for operation, and the water shall flow in an all-brass waterway. All working parts shall be made of brass and shall be removable from above ground without digging. A copper vent tube shall allow the station to be pumped free of standing water. The vent tube shall be opened or closed via an easily accessible pet cock. Exterior piping shall be galvanized. The sampling station shall be Kupferle "Eclipse No. 88", or approved equal.

1.22 STANDARD METER BOX

A. Meter boxes for all 5/8", 1", and 1-1/2" water meters will be provided by the City of Savannah Water Distribution Department upon purchase of the meter.

B. For 2" water meter installations, please refer to the City of Savannah Standard Construction Detail W-5A.

C. For 3" and larger water meter installations, please refer to the City of Savannah Standard Construction Detail W-5B.

1.23 COUPLINGS

All couplings shall be mechanical joint solid sleeves. All Couplings shall be compact Class 350 ductile iron, manufactured in accordance with ANSI / AWWA A21.53 / C153, latest revision. Mechanical joints shall be manufactured in accordance with ANSI / AWWA A21.11/C111. All couplings shall be cement lined in accordance with ANSI/AWWA A21.4/C104. Mechanical joint nuts and bolts shall be Corten or ductile iron, high strength, low alloy steel per ANSI/AWWA A21.11/C111. An asphaltic coating with a thickness of one (1) mil shall be applied to all couplings. Couplings shall be designed to accommodate the type of pipe used. Couplings or fittings in accordance with Part 1.03 shall be used at all transitions from ductile iron to PVC pipe.

1.24 BLOW-OFF HYDRANTS

All blow-off hydrants shall be manufactured to fit in a standard 5¼" valve box and shall include a two (2) inch coupling riser and a self draining valve with a two (2) inch FIP inlet connection. The operating screw shall fit a standard 3/4" bolt socket or a 7/8" pentagon. All working parts shall be brass, and shall be removable without excavation. All blow-off hydrants shall be equal to the TF500 Blow Off Hydrant by The Kupferle Foundry Company of St. Louis, Missouri.

1.25 BACKFLOW PREVENTION DEVICES

All service laterals shall include backflow prevention devices in accordance with the City of Savannah Cross Connection Control Policy.

1.26 BEDDING AND BACKFILL

A. Classification of Materials – ASTM D-2321 classifies soils using the Unified Soils Classification System (ASTM D-2487). For the purpose of this specification, soils to be used as backfill material are grouped into five classes according to soil properties and characteristics.

1. Class I - Angular, 1/4 to 1-1/2 inch graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, crushed gravel, and crushed shells.

2. Class II - Coarse sands and gravels with maximum practical size of 1-1/2 inch, including variously graded sands and gravels containing small percentages of fines,

generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class.

3. 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. These materials are not to be used for bedding or haunching.

4. 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 are not to be used for bedding, haunching, or initial backfill.

5. Class V - This class includes the organic soil, OL, OH, PT as well as soils containing frozen earth, debris, rocks, larger than 1-1/2 inch in diameter, and other foreign materials. These materials are not to be used.

B. Stone Bedding - Stone used for foundation and bedding shall be shall be crushed stone or gravel conforming to ASTM C33, Size #57, with size range of ¼ to 1-inch, free from debris, roots, trash, stones, or other harmful substances.

C. Backfill – Whether imported borrow material or from on-site excavations, backfill shall be suitable Class II or Class III material. Backfill material shall be free from debris, roots, trash, stones, or other harmful substances. Suitable soils are those complying with ASTM-2487 soil classification groups GW, GP, GM, SW, SP, and SM, as defined in ASTM D2487.

1. Common Backfill

   Common backfill shall consist of mineral soil, substantially free of clay, organic material, loam, wood, trash, and other objectionable material which may be compressible or which cannot be compacted properly. Common backfill shall not contain stones larger than 6 inches in any dimension, asphalt, broken concrete, masonry, rubble, or other similar materials.

   The backfill shall have physical properties such that it can be readily spread and compacted during filling. Additionally, common backfill shall be no more than 12 percent by weight finer than the No. 200 mesh sieve unless finer material is approved for use in a specific location by the City.

   Material falling within the above specifications, encountered during the excavation, may be stored in segregated stockpiles for reuse. All material which, in the opinion

of the Engineer, is not suitable for reuse on the site shall be removed and disposed of by the Contractor.

2. Select Backfill

Select Backfill shall be as specified above for common backfill, except that the material shall contain no stones larger than 1-1/2 inches in largest dimension, and shall be no more than 5 percent by weight finer than the No. 200 mesh sieve.

3. Borrow Material

Where it is determined that sufficient suitable material is not available from the site to satisfactorily backfill the pipe to at least two (2) feet above the top of the pipe, suitable borrow material meeting the requirements of this specification unless otherwise noted, shall be provided by the Contractor from other sources at Contractor's expense. All material from the excavation unsuitable for bedding, backfill, or other uses as directed by the Engineer and approved by the Owner, shall be removed and disposed of by the Contractor.

1.27 PRODUCT REVIEW

The Contractor shall provide the Engineer with a complete description of all products before ordering. The Engineer shall review and approve all products before they are ordered.

PART 2 – EXECUTION

2.01 USE OF STANDARD CONSTRUCTION TECHNIQUES

A. Responsibility for Proper Construction - The standard construction techniques presented herein for bedding, backfill, and compaction are suitable in areas of favorable soils. However, the ENGINEER SHALL REMAIN RESPONSIBLE FOR CONDUCTING ON-SITE SOILS INVESTIGATIONS appropriate for the nature of the project at hand. The ENGINEER SHALL REMAIN FURTHER RESPONSIBLE for providing the procedures and details necessary for proper waterline installation throughout the entire project corridor.

B. Minimum Site Soils Investigation Requirements - All projects requiring the installation of any water or sanitary pipe other than service laterals shall require a minimum of one (1) soil boring every 300 linear feet along the proposed utility corridor. Borings shall be to a depth of two (2) feet deeper than the deepest proposed line within 150 feet. A

Geotechnical Report identifying the type(s) of soils found on the project site shall be provided with the construction plan submittal. The report shall include, at a minimum, boring logs, (types of soils encountered, e.g. - type GW, GP, SW, SP, etc., depths of soil types, observed groundwater, seasonal high groundwater, etc.), and any special requirements for pipe bedding, backfill, or compaction. The location of the boring(s) shall be clearly shown on the construction plans.

C. Use of Standard Procedures and Details - If site-specific procedures or details for bedding, backfill, compaction, and joint restraint are not provided in the contract documents and the Engineer includes only the standard City of Savannah specifications and details for pipe bedding and joint restraints, the ENGINEER IS ATTESTING THAT SOIL CONDITIONS ARE FAVORABLE, and that the STANDARD METHODS ARE ACCEPTABLE based on the soil conditions observed and the Engineer's experience.

2.02 INSTALLATION

Ductile iron pipe shall be laid in accordance with ANSI/AWWA C600; Plastic pipe shall be laid in accordance with AWWA M23, ASTM D2774, UNI-Bell UNI-B-3 and the pipe manufacturer's recommendations.

A. Alignment and Grade - The water mains shall be laid and maintained to lines and grades established by the plans and specifications, with fittings, valves, and hydrants at the required locations unless otherwise accepted by the owner. Valve-operating stems shall be oriented in a manner to allow proper operation. Hydrants shall be installed plumb.

1. Prior Investigation - Prior to excavation, locate request shall be called into Georgia 811, and investigation shall be made to the extent necessary to determine the location of existing underground structures and conflicts. Care shall be exercised by the contractor during excavation to avoid damage to existing structures. The pipe manufacturer's recommendations shall be used when the watermain being installed is adjacent to a facility that is cathodically protected.

2. Unforeseen obstructions - When obstructions that are not shown on the plans are encountered during the progress of work and interfere so that an alteration of the plans is required, the owner will alter the plans, or order a deviation in line and grade, or arrange for removal, relocation, or reconstruction of the obstructions.

3. Clearance - When crossing existing pipelines or other structures, alignment and grade shall be adjusted as necessary, with the acceptance of the owner, to provide

clearance as required by federal, state, and local regulations or as deemed necessary by the owner to prevent future damage or contamination of either structure.

4. Depth of Pipe - The Contractor shall perform excavation of whatever substances are encountered to a depth that will provide a minimum cover over the top of the pipe from the finished grade:

Pipe	Minimum Cover
Diameter ≤ 12-inches	36-inches
Diameter > 12-inches	48-inches
Laterals	36-inches under paved or traffic areas or 24-inches under non-paved, non-traffic areas

A maximum cover of 60-inches from finished grade shall be used unless approved by the City to avoid a conflict. If the depth of cover will be less than the minimum required, ductile iron pipe shall be used.

5. Fluorinated Hydrocarbon Gaskets -Fluorinated hydrocarbon gaskets are intended for use in soils where a possibility of petroleum contamination is present. Fluorinated hydrocarbon gaskets shall only be used where specifically called for on the drawings.

B. Trench Construction - The trench shall be excavated to the alignment, depth, and width specified or shown on the plans and shall be in conformance with all federal (i.e. OSHA), state, and local regulations for the protection of the workers.

1. Trench Preparation - Trench preparation shall proceed in advance of pipe installation only as far as stated in the specifications or as directed by the Owner. Discharge from any trench-dewatering pumps shall be conducted to natural drainage channels, storm sewers, or as directed by applicable regulatory agencies.

   A four-inch layer of loose backfill shall be provided on the trench bottom to conform to and evenly support the pipe bottom. Material shall be Class II select backfill material (coarse clean sand), and shall remain un-compacted until placement of the pipe into the trench. In lieu of placing the four-inch loose backfill layer, and provided that the trench bottom will provide suitable pipe bedding material, the Contractor may loosen the bottom of the trench using an excavator bucket with four-inch teeth.

Excavated material shall be placed in a manner that will not obstruct the work nor endanger the workers or the public, or obstruct sidewalks, driveways, roadways, or other structures. Placement of excavated material shall be done in compliance with federal, state, and local regulations.

2. Pavement Removal - Removal of pavement and road surfaces shall be a part of the trench excavation. The amount removed shall depend on the width of trench required for installation of the pipe and the dimensions of the area into which valves, hydrants, manholes, or other structures will be installed. The dimensions of pavement removed shall not exceed the dimensions of the opening required for installation of pipe, valves, hydrants, specials, manholes, and other structures by more than six (6) inches in any direction, unless otherwise required or accepted by the owner. Methods such as sawing, drilling, or chipping shall be used to ensure the breakage of pavement along straight lines. Pavement removal shall occur in accordance with the City of Savannah standard details.

3. Width - The width of the trench at the top of the pipe shall be the same as that afforded by the single-pass capabilities of normally available excavating equipment, and shall be ample to permit the pipe to be laid and joined properly and to allow the backfill to be placed as specified. Trenches shall be of such extra width, when required, to permit the placement of timber supports, sheeting, bracing, and appurtenances as required by the safety requirements of the agency having jurisdiction.

4. Bell Holes - Holes for the bells shall be provided at each joint, but shall be no larger than necessary to allow joint assembly and to ensure that the pipe barrel will lie flat on the trench bottom. Push-on type joints require only minimum depressions for bell holes. Other than noted previously, the trench bottom shall be true and even to provide support for the full length of the pipe barrel, except that a slight depression may be provided to allow withdrawal of pipe slings or other lifting tackle without damaging coating or polyethylene encasement.

5. Clearances - Clearances and bedding procedures shall be observed for pieces of concrete or masonry and other debris or subterranean structures, such as masonry walls, piers, or foundations that may be encountered during excavation. When encountered, all structures shall be removed to provide a clearance below and on each side of all pipe, valves, and fittings of at least 18-inches for pipe sizes 24-inches or smaller and 24-inches for pipe sizes 30-inches or larger. When excavation is completed, Class II or better select backfill material (graded stone, gravel, or coarse

sands), shall be placed on the bottom of the trench to the previously mentioned depths, leveled, and tamped.

6. Previous excavations - Should the trench pass over a sewer or other previous excavation, the trench bottom shall be sufficiently compacted to provide support equal to that of the native soil or to conform to other regulatory requirements in a manner that will prevent damage to the existing installation.

7. Protection of Property - Trees, shrubs, fences, and all other property and surface structures shall be protected during construction, unless their removal is shown in the plans and specifications or directed by the owner. Any cutting of tree roots or branches shall be done only as directed by the City of Savannah Engineering Department. Temporary support, adequate protection, and maintenance of all underground and surface structures, drains, sewers, and other obstructions encountered in the progress of the work shall be provided in accordance with specifications or applicable regulations. All properties that have been disturbed shall be restored as nearly as practical to their original condition.

8. Unsuitable subgrade material - When the subgrade is found to include ashes, cinders, refuse, organic material, or other unsuitable material, such material shall be removed to a minimum of at least six (6) inches below the bottom of the pipe or to the depth ordered by the Engineer. The removed material shall be replaced, under the direction of the Engineer, with Class II or better select backfill material (coarse clean sands). The bedding shall be consolidated and leveled so that the pipe may be installed.

9. Safety - Appropriate traffic-control devices shall be provided in accordance with federal, state, and local regulations to regulate, warn, and guide traffic at the work site.

C. Pipe Installation - Proper implements, tools, and facilities shall be provided and used for the safe and convenient performance of the work. All pipe, fittings, valves, and hydrants shall be lowered carefully into the trench by means of a derrick, ropes, or other suitable tools or equipment, in such a manner as to prevent damage to water main materials and protective coatings and linings. Under no circumstances shall water main materials be dropped or dumped into the trench. Where necessary, the trench shall be dewatered prior to installation of the pipe. Chains shall not be allowed to transport or lower pipe into the trench or ditch.

1. Examination of material - All pipe, fittings, valves, hydrants, and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Damaged or defective materials will not be accepted or installed.

2. Pipe ends - All lumps, blisters, and excess coating shall be removed from the socket and plain ends of each pipe, and the outside of the plain end and the inside of the bell shall be wiped clean and dry and be free from dirt, sand, grit, or any foreign materials before the pipe is laid.

3. Pipe cleanliness - Foreign material shall be prevented from entering the pipe while it is being placed in the trench. No debris, tools, clothing, or other materials shall be placed in the pipe at any time. Excessive flush water required to clean the pipe after installation may be charged to the Contractor.

4. Pipe placement - As each length of pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with acceptable backfill material.

5. Direction of bells - It is common practice to lay pipe with the bells facing the direction in which work is progressing; however, it is not mandatory. For example, when the main is being laid on a slope, the pipe is frequently laid with the bells facing uphill for ease of installation. The direction of the bells is not functionally related to the direction of flow within the main.

6. Pipe plugs - At times when pipe-laying is not in progress, the open ends of pipe shall be closed by a temporary watertight plug approved by the City. The plug shall be fitted with a means for venting. When practical, the temporary plug shall remain in place until the trench is pumped completely dry. Care must be taken to prevent pipe flotation, should the trench fill with water. Prior to removal of a permanent plug for extending the line or for any other reason, air and/or water pressure in the line shall be released.

7. Joint deflection - When it is necessary to deflect pipe from a straight line in either the horizontal or vertical plane, the amount of joint deflection shall not exceed that shown in Tables 1 or 2. The deflections listed are maximum deflections and shall not be exceeded.

8. Pipe cutting - Cutting pipe for insertion of valves, fittings, or closure pieces shall be

done in conformance with all safety recommendations of the manufacturer of the cutting equipment. Cutting shall be done in a safe, workmanlike manner without creating damage to the pipe or cement-mortar lining.

9. Cut ends and rough edges shall be ground smooth, and for push-on joint connections the cut end shall be beveled by methods recommended by the manufacturer and accepted by the City.

D. Valve and Fitting Installation

1. Examination of material - Prior to installation, valves shall be checked for direction of opening, number of turns to open, freedom of operation, tightness of bonnet bolts and test plugs, cleanliness of valve ports and especially seating surfaces, handling damage, and cracks. Valves shall be closed before being installed.

2. Placement - Valves, fittings, plugs, and caps shall be set and joined to the pipe in the manner specified in Sec. C for cleaning, laying and joining pipe, except that 12-inch and larger valves should be provided with special support, such as crushed stone, concrete pads, or a sufficiently tamped trench bottom so that the pipe will not be required to support the weight of the valve. Valves shall be installed in the closed position.

3. Valve location - Valves in water mains shall, where practical, be located within or immediately adjacent to the street property lines unless shown otherwise on the plans.

4. Mains shall be drained through drainage branches or blow-offs. Drainage branches, blow-offs, air vents, and appurtenances shall be provided with control valves and shall be located and installed as shown on the plans. Drainage branches or blow-offs shall not be directly connected to any storm or sanitary sewer, submerged in any stream, or be installed in any other manner that will permit back siphonage into the distribution system.

5. In no case shall valves be used to bring misaligned pipe into alignment during installation. Pipe shall be supported in such a manner as to prevent stress on the valve.

6. Plugs and Caps - All dead ends on new mains shall be closed with plugs or caps that are suitably restrained to prevent blowing off under test pressure. If a blow-off

valve precedes the plug or cap, it too shall be restrained against blowing off. All dead ends shall be equipped with suitable blow-off facilities.

TABLE 1

MAXIMUM JOINT DEFLECTION*
FULL-LENGTH PIPE PUSH-ON TYPE JOINT DUCTILE IRON PIPE

		Maximum Offset - S (in)		Approx. Radius of Curve R Produced by Succession of Joints (ft)	
Nominal Pipe Size (in)	Deflection Angle (Degrees)	L = 18 ft	L = 20 ft	L = 18 ft	L = 20 ft
4	5	19	21	205	230
6	5	19	21	205	230
8	5	19	21	205	230
10	5	19	21	205	230
12	5	19	21	205	230
14	3*	11	12	340	380
16	3*	11	12	340	380
18	3*	11	12	340	380
20	3*	11	12	240	380
24	3*	11	12	240	380
30	3*	11	12	340	380
36	3*	11	12	340	380
42	3*	11	12	340	380
48	3*	-	12	-	380

* For 14-inch and larger push-on joint, maximum deflection angle may be larger than shown above. Consult the manufacturer.

TABLE 2

MAXIMUM JOINT DEFLECTION
FULL-LENGTH PIPE-MECHANICAL-JOINT PIPE

		Maximum Offset - S (in)		Approx. Radius of Curve R Produced by Succession of Joints (ft)	
Nominal Pipe Size (in)	Deflection Angle (Degrees)	L = 18 ft	L =20 ft	L = 18 ft	L = 20 ft
4	8° 18′	31	35	125	140
6	7° 07′	27	30	145	160
8	5° 21′	20	22	195	220
10	5° 21′	20	22	195	220
12	5° 21′	20	22	195	220
14	3° 35′	13.5	15	285	320
16	3° 35′	13.5	15	285	320
18	3° 00′	11	12	340	380
20	3° 00′	11	12	340	380
24	2° 23′	9	10	450	500
30	2° 23′	9	10	450	500
36	2° 05′	8	9	500	550
42	2° 00′	7.5	8	510	570
48	2° 00′	7.5	8	510	570

E. Hydrants - Hydrants shall be set at such elevations that the connecting pipe and tee will have the same depth of cover as the distribution mains. Extensions on fire hydrants shall not be allowed, final grade adjustment must be made when hydrant is installed. Hydrants and valves shall have the interiors cleaned of all foreign matter before installation. Not less than seven (7) cubic feet of crushed stone shall be placed around the base of the hydrant. See Details W-36 or W-37 for hydrant installation.

1. Where hydrants are to be moved, the lateral shall be extended with six (6) inch pipe, and the hydrant reinstalled at the end of the lateral. Minimum clearance under steamer cap on fire hydrants shall be 18 inches from final grade.

2. Existing hydrants that are relocated, and therefore, temporarily out of service, shall be placed in service within a period of 24 hours. All preliminary connection requirements shall be completed as promptly as possible to insure that the hydrant is operational within the above time frame. The contractor shall be responsible for insuring that valves on the hydrant laterals are accessible and remain in an open position. Payment for relocated hydrants will not be made until the hydrant has been checked and is operational. In the event that the 24-hour time schedule cannot be met, due to conditions beyond the control of the contractor, then the contractor shall so notify the City Water Distribution Administrator. It shall then be the responsibility of the latter to notify the City Fire Department and identify the location of the inactive hydrant. Once the hydrant is in service, it shall be the responsibility of the Contractor to so advise the City Water Distribution Administrator.

3. The time frame and procedures outlined in the above paragraph shall also apply for old hydrants replaced with new hydrants. Old hydrants shall be removed as soon as new hydrants are placed in service and shall be delivered to the City Lot.

4. Anchorage for hydrants shall be provided using Megalug joint restraints or equal.

F. Backfill and Compaction - All trenches and excavation shall be backfilled immediately after the pipes are laid therein, unless other protection of the pipe line is directed.

1. Initial Backfill – Initial backfill shall be from the bottom of the pipe (above loose bedding layer) to two (2) feet above the pipe.

   From the bottom of the pipe to the top of the pipe, Class II select backfill material (coarse clean sand) shall be placed and compacted into six (6) inch lifts. The backfilling of the trench above the pipe shall be carried on simultaneously on both sides of the pipe in such a manner that injurious side pressure does not occur. From the top of the pipe to two (2) feet above the pipe, Class III or better select backfill material (coarse clean sand with some silt) shall be placed and compacted into twelve (12) inch lifts. Each layer shall be spread uniformly and tamped until thoroughly compacted.

   Initial backfill material shall be selected and deposited with special reference to the future safety of the pipes. The material shall be select backfill completely void of rocks, stones, bricks, roots, sticks or any other debris that might cause damage to the pipe and tubing or that might prevent proper compaction of the backfill.

2. Final Backfill - Except where special methods of bedding and tamping are provided, common backfill material (Class IV or better) shall be placed in lifts from two-feet above the top of the pipe to final grade. Backfill may be selected from excavated material anywhere on the work if any of the material is suitable. Backfill may be by hand or mechanical placement. Trench backfill above the embedment zone shall be compacted in twelve (12) inch lifts.

2. Compaction - Under traffic areas, the top 12-inches of backfill material shall be compacted to a density of not less than 100% as determined by ASTM D1556 or D-2922. Below the 12-inch line to, and including the area around the pipe, the density shall not be less than 95% at optimum moisture. In areas other than traffic areas, the backfill shall be compacted to 95% density, at optimum moisture. Laboratory test shall conform to ASTM-D-698.

3. Whenever the trenches have not been properly filled, or if settlement occurs, they shall be refilled, smoothed off and finally made to conform to the surface of the ground. Backfilling shall be carefully performed, and the original surface restored to the full satisfaction of the Engineer immediately after installation. The finished surface shall be free of depressions and shall not allow ponding of stormwater runoff above utility lines.

4. Where PVC pipe is installed, the Contractor shall take precautions, in accordance with ASTM D2321, during the backfill operations so as not to create excessive side pressures, horizontal or vertical deflection of the pipe so as not to impair flow capacity.

G. Joint Restraint - All bends, plugs, valves, caps and tees on four (4) inch pipe and larger, shall be provided with joint restraints equivalent to Megalugs. Additional restraint shall be as indicated on the drawings.

H. New Service Connections - The Contractor shall tap the main and install a service connection to each vacant lot or as directed by the Engineer in accordance with the detail shown on the plans for Water Service Connections. Plastic or copper tubing for service lines shall be installed in a manner that will prevent abrupt changes or bends in any direction. Tracer wire in accordance with Part 1.06 shall be installed on all service laterals extending from the main to the curb stop. The Contractor shall exercise extreme caution to prevent crimping of the tubing during handling, storage and installation. All one (1) inch and two (2) inch service laterals shall be of one piece construction, no couplings or sectional lines will be allowed from the corporation stop to

the curb stop. The tubing shall have an absolute positive connection to the water main to prevent leakage. Taps shall be made perpendicular to the main. A water service connection shall be marked on the curb with a "W". The mark shall be made with a branding iron on the vertical face of the curb and shall be a minimum of 1/4-inch in depth. All laterals shall be locked during construction, testing and disinfection. The Contractor may unlock the laterals only when water is being blown off to prepare for testing. When the water system is accepted by the City, all laterals shall be completed by removing the locks and placing the curb stop in a Standard Meter Box as shown on the Detail. Copper tubing is intended for use in soils where a possibility of petroleum contamination is present and shall only be used where specifically called for on the drawings.

I. Connect Existing House Service - The Contractor shall tap the main and install a house service connection to each existing water meter. Taps shall be made perpendicular to the main and opposite the existing meter. Plastic tubing for house service lines shall be installed in a manner that will prevent abrupt changes or bends in any direction. The Contractor shall exercise extreme caution to prevent crimping of the tubing during handling, storage, and installation. All one (1) inch and two (2) inch service laterals shall be of one piece construction; no couplings or sectional lines will be allowed from the corporation stop to the curb stop. The tubing shall have an absolute positive connection to the water main to prevent leakage. The Contractor shall locate and excavate the existing lateral connections, cut and plug the existing lateral at the main, remove the existing curb stop, and connect the new lateral to the meter. The new work shall be tested, cleaned and disinfected prior to connecting to the existing meter. All laterals shall be locked during construction, testing and disinfection. The contractor may unlock the laterals only when water is being blown off to prepare for testing or when the laterals are being connected to the existing meters.

J. Jacking and Boring - Steel casing of the diameter shown on the plans shall be jacked or bored in the location indicated. Joints between sections of the steel casing shall be of a continuous weld made by a certified welder. Boring or jacking shall be in accordance with the provisions of Section 615 of the Georgia DOT Standard Specifications. Carrier pipe shall be installed as shown on the Detail. After the carrier pipe has been installed, the ends of the casing shall be sealed with Class "C" concrete after being checked by the Engineer.

Where the work involves a highway, the Resident Engineer of the State Department of Transportation shall be notified three (3) days before the crossing is started. Where the work involves a railroad, the work shall conform to the requirements of AREMA

specifications and the Division Superintendent of the Railroad shall be notified three (3) days prior to beginning the work. Before commencing work within the rights-of-way of the railroads or highways, the Contractor shall verify that the Owner has obtained the required permits.

K. Detection Tape - Detection tape will be used over all pipe and tubing two (2) inch or larger. The tape shall be laid 24" above existing main. Tracer wire shall be securely fastened to fire hydrants, valves, and valve covers according to the specification. Locate wire for laterals shall extend one (1) foot beyond the curb stop.

L. Tracer Wire - Tracer wire will be installed on all water mains and connected with direct burial sealed connection on all water service laterals directly on top of the water line. Tracer wire shall be attached directly to the pipe in the 3 o'clock position and shall be securely fastened to fire hydrants, valves, and valve covers according to the specification. Locate wire for laterals shall extend one (1) foot beyond the curb stop. The wire shall be secured to the pipe with tape or other acceptable methods at spacing of no more than 36" apart. Where water service laterals connect to water mains, the specified spliced connector shall used. The insulated wire must maintain electrical continuity. This tracer wire system shall be checked and tested by the contractor, in the presence of City personnel, prior to acceptance of the water main installation. All equipment, meters, detectors, etc., needed for testing shall be furnished by the Contractor.

M. Polyethylene Encasement - Polyethylene encasement shall be used on all ductile iron piping, fittings, valves and appurtenances and installed according to the requirements of ANSI/AWWA C105/A21.5, Sec. 5.4, Method A.

N. Air Relief Valves - Tapping saddles shall be used when installing air relief valves on non-metallic pipe less than six (6) inches in diameter. A direct tap shall be made on all pipe six (6) inches in diameter and larger.

2.03 LOWERING WATER MAINS

A. The existing water lines shall be lowered to the control elevations shown on the plans or as specified by the Engineer. The water mains that are to be lowered shall be completely uncovered to the bottom of the main. At all changes in grade or line, the pipe shall be firmly wedged against the vertical face of the trench to prevent a joint from blowing off. The main shall be lowered to its new elevations by removing the earth from under the main and along-side the pipe uniformly. Deflections in the joints

of the main, while lowering or when its final lowered position shall not exceed three (3) degrees for an 18 foot length of pipe. All joints shall be reworked with Megalugs so that they do not leak. The joint work shall be done in such a manner as to secure tight joints without over straining the bell. The lowered pipe shall be true to line and grade.

B. Trench Excavation - Trenches shall be of necessary width for the proper lowering of the pipe. The bottom of the trenches shall be accurately graded to provide uniform bearing and support for each section of the pipe on undisturbed soil at every point along its entire length, except for the portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded. In order that the pipe rests upon the prepared bottom for as nearly its full length as practicable, the depressions shall be only of such length, depth, and width as required for properly making the particular type of joint. Care shall be taken not to excavate below the depths indicated. Unauthorized over excavation shall be backfilled with accepted backfill material and compacted per Section 2.02, Paragraph B.8, at no cost to the Owner. Unstable soil that is not capable of properly supporting the pipe shall be removed to a minimum of at least 6 inches below the bottom of the pipe or to the depth ordered by the Engineer, and replaced with accepted backfill material and compacted per Section 2.02, Paragraph B.8.

2.04 OFFSET EXISTING WATER MAINS

Where water mains must be offset to avoid interference with new structure or pipe the contractor shall notify the Engineer for instructions and methods for said work. Prior to any work on existing mains, the Contractor shall notify the Water Distribution Administrator a minimum of four (4) days in advance of required shut-off.

2.05 SEPARATION BETWEEN WATER AND SEWER

Water mains and/or laterals shall not be laid closer than 10 feet horizontally to a sanitary or storm sewer without written instruction from the engineer. Some deviation may be allowed on a case by case basis if approved by the City for installation of the water main closer to a sewer, provided that the water main is laid in a separate trench, such that the bottom of the water main is at least 18 inches above the top of the sewer. In no case, shall the water and sewer lines be closer than five (5) feet horizontally edge to edge. Water mains crossing sewers should be laid to provide a minimum vertical distance of 18 inches between the invert of the water main and the top of the sewer line. The water and sewer lines must be ductile iron when laid in violation of the

separation requirements. One full length of water pipe shall be located so both joints will be as far from the sewer as possible.

2.06 PROCEDURES FOR CONNECTIONS OF WATER MAINS

A. Purpose - To insure that there is a physical disconnection of any new untested water main from existing water mains owned and operated by the City of Savannah.

B. Procedure - Any physical connection of untested water mains with existing City of Savannah water mains is prohibited except when acceptable backflow prevention devices have been installed, tested and checked by City personnel.

1. Any new water main to be tested must be capped and restrained with retaining glands to prevent blow out or leakage during the pressure testing.

2. Water for filling and flushing the new water main will be obtained from only approved and specified fire hydrant or special wet tap of the existing City main. This physical connection for obtaining water for the new untested main shall be protected by a RPZ backflow preventer. Appropriate taps of sufficient size must be made at the end of the new system to allow air to escape during the filling sequence.

3. This physical tie-in with the existing City System must be physically disconnected after sufficient water for hydrostatic testing and disinfection has been obtained.

4. Once the new water system has passed hydrostatic testing requirements and has been chlorinated in accordance with paragraph 2.07, the new system must be flushed using the filling method in Step Two (2). The system or main will then be subjected to bacteriological testing. After bacteriological test the system must be open flushed and connected to existing system within 72 hours.

5. The permanent connection to the new system must be made with clean materials. The connection will be made with solid ductile iron sleeves. Any connection with stainless steel or similar metal full circle clamps is prohibited. Once the connection has been made, the new system must be flushed using water from the existing system to insure adequate flow and velocity into the new water system.

6. If a wet tap is required, the contractor will be responsible for preparing the site. This preparation includes the excavation and installation of the tapping sleeve. The Contractor will make available a lifting device for the tapping machine.

The City will provide the tapping machine, the air compressor, and one man to operate the unit. All taps of 12" and smaller diameter will be made by the City Water Distribution Department unless authority has been granted in writing by the Water Distribution Superintendent for a private firm to perform the wet tap for a particular new main.

C. Water for Construction - Metering Requirements

1. All water used for construction shall be metered. Water meters, either temporary or permanent, shall be the responsibility of the contractor to purchase from the City.

2. Fire hydrant meters obtained from the City of Savannah shall be obtained by submitting an application to the Water and Sewer Planning and Engineering Department with a deposit of $ 1,000.00 to cover the cost of any damage or theft of meters.

3. Fire hydrant meters shall be picked up at the Water Operations Department by presenting the receipt for the $ 1,000.00 deposit noted above.

   Fire hydrant meters shall be brought to the Water Distribution Department for inspection and testing at least twice a year.

4. A double check valve will be installed on the fire hydrant meter prior to usage. The double check assembly provided shall be the responsibility of the contractor to remain connected at all times. No fire hydrant meter shall be used without a double check valve assembly. The fire hydrant meter shall be directly connected to the fire hydrant and the double check assembly shall be connected to the meter with the 4-inch fire hose provided by the City in order to relieve weight on the fire hydrant 2½-inch outlet.

5. The contractor shall be responsible to notify the Water Revenue Office of the location of the fire hydrant meter on a bi-monthly basis for the purpose of billing. Water Revenue will inform the contractor of the required date for the call-in during the initial meter application process. Failure to call in on the required date shall result in immediate confiscation of the meter and return of the deposit minus the cost of the water used and/or damages to the meter.

6. It shall be the responsibility of the contractor to estimate the volume of water required during construction and include the cost in the installation price of the water main.

7. When fire hydrant meters are returned to the Water Distribution Department, an inspection and test will be made on the meter. Any damage to the meter shall be deducted from the deposit made by the Contractor.

D. All permanent or temporary meters installed shall be equipped with double check valves or RPZ which will be the responsibility of the contractor to install in accordance to the specifications. Construction meters shall be obtained through the normal meter application process. Construction meters shall be used during all phases of the construction project. Upon completion of the project, the meter must be disconnected and returned to the Water Distribution Department for final processing and return of the deposit for the meter. All laterals to the meter shall be removed from the tap at the main to the meter location.

2.07 TESTING, FLUSHING, AND DISINFECTION OF NEW WATER MAINS

A. Filling and Hydrostatic Testing of New Mains:

Upon complete installation and prior to connection to the City's existing water mains, all new water mains shall be hydrostatically tested in accordance with Section 02550, Part 3.01 of these specifications. Where any portion of the line fails to meet the hydrostatic requirements of Section 02550, Part 3.01, repairs shall be made and the entire new main shall be retested. All filling and hydrostatic testing of new mains shall be coordinated with and witnessed by the City's inspector.

Temporary connections to the City's existing water system for the purpose of filling and/or flushing of new mains shall be approved by the City's inspector prior to installation of said connections. A City of Savannah approved double detector check valve backflow prevention device shall be used for all such temporary connections. A test certification shall be required on all backflow prevention devices not supplied by the City of Savannah prior to their use. The test certification shall indicate that the backflow prevention device has been tested and approved within the previous 12 months, by an individual holding a valid State of Georgia Backflow Prevention Assembly Tester license.

The rate at which new mains are filled shall be controlled to allow air to escape the mains during the filling process and to prevent sudden increases in system pressure due to water hammer at such time as the line becomes full. The rate of filling may also be limited by system operation requirements as determined by the City's Water Supply and Treatment Department.

Under NO circumstance, other than a life threatening emergency, shall the contractor, his employees, and/or representatives operate any valve which will allow flow into or out of the City's existing water system. In the event of a non-life threatening emergency condition, the Contractor shall contact the City's inspector or the City's Water Supply and Treatment Department (912-351-3434) for approval prior to valve operation.

B. Flushing of New Mains

Upon successful completion of hydrostatic testing, all new mains shall be flushed to remove all foreign material from within the mains. Flushing shall generally be accomplished at the highest practical flow rate. However, limitations of existing water system operational demand and pressure, as well as drainage areas receiving flush water may exist. Such flow rate limitations shall not relieve the contractor from providing a clean water main and all requirements of chlorination and bacteriologic sampling shall remain in full force (see Section 02550, Parts 2.07 C and 2.07 E).

Not less than 48 hours (2 working days) prior to the desired commencement of flushing, the Contractor shall contact the City's inspector for the purpose of coordinating the flushing effort.

Prior to flushing, the Contractor shall identify the area(s) into which flushed water will be drained. Such drainage area shall be approved by the City's inspector prior to flushing. The Contractor shall provide sufficient supervision to monitor the designated drainage area and to insure that flooding and/or erosion of private property does not occur. Where public roadways are to be used, the Contractor shall monitor water volumes and traffic to insure flushing does not create a traffic hazard. The Contractor may request that an affected street be closed to traffic during the flushing period. However, such closings shall be subject to the requirements and approval of the City's Traffic Engineering Department.

Under NO circumstance, other than a life threatening emergency is the contractor, his employees, and/or representatives to operate any valve which will allow flow into or out of the City's existing water system. In the event of a non-life threatening emergency condition, the Contractor shall contact the City's inspector or the City's Water Supply and Treatment Department (912-351-3434) for approval prior to valve operation.

1. Water Mains 10" and Smaller

For water mains with a nominal diameter up to and including 10 inches, the double

detector check valve installed between the existing City's water main and the new main to be flushed shall be no less than 6 inches in diameter.

Flushing shall continue until the water is clear to the eye and no foreign material is observed. Examination for sediment in a sample collected in a clear container and allowed to stand for approximately 5 minutes will provide an indication of the necessity to continue flushing. Termination of flushing based on such an indication shall not relieve the contractor from providing a clean water main and all requirements of chlorination and bacteriologic sampling shall remain in full force (see Section 02550, Parts 2.07 C and 2.07 E).

2. Water Mains 12" and Larger

For water mains with a nominal diameter of 12 inches and larger, the double detector check valve installed between the existing City's water main and the new main to be flushed shall be no less than 10 inches in diameter.

For new water mains 12 inches in diameter and larger, the Contractor shall collect a sample from the flushed main that is apparently clear and shall deliver same to the Water Supply and Treatment laboratory located at the I&D Water Plant for examination and determination of apparent successful flushing. Review of the sample by the laboratory is only an indication of apparent successful flushing and shall in no way imply that disinfection will be successful or that satisfactory bacteriological tests will be obtained. Termination of flushing based on such an indication shall not relieve the contractor from providing a clean water main and all requirements of chlorination and bacteriologic sampling shall remain in full force (see Section 02550, Parts 2.07 C and 2.07 E).

C. Disinfection of New Mains

All new water mains shall be disinfected in accordance with these specifications prior to being connected to the City's existing water system.

1. Chemicals to be used in the disinfection of new water mains shall be as follows:

   a. Liquid (gas) Chlorine – conforming to ANSI/AWWA B301 containing 100% available chlorine and packaged in steel containers. Liquid chlorine shall be used only 1) in combination with appropriate gas-flow chlorinators and ejectors to provide a controlled high-concentration solution feed to the water be

chlorinated; 2) under the direct supervision of someone familiar with the physiological, chemical, and physical properties of liquid chlorine and who is trained and equipped to handle any emergency that may arise; and 3) when appropriate safety practices are observed to protect working personnel and the public.

b. Sodium hypochlorite – conforming to ANSI/AWWA B300. The granular or tablet form of sodium hypochlorite shall NOT be introduced directly into water lines. The use of sodium hypochlorite shall require that all granules or tablets shall be completely dissolved in an appropriate amount of water to obtain the desired chlorine concentration. The sodium hypochlorite solution may then be pumped into the new mains to achieve required levels of free chlorine for disinfection.

c. Calcium hypochlorite – conforming to ANSI/AWWA B300. The granular or tablet form of sodium hypochlorite shall NOT be introduced directly into water lines. The use of calcium hypochlorite shall require that all granules or tablets shall be completely dissolved in an appropriate amount of water to obtain the desired chlorine concentration. The calcium hypochlorite solution may then be pumped into the new mains to achieve required levels of free chlorine for disinfection.

d. No pool treatment chemicals containing algaecide will be allowed for use of disinfecting of potable water lines.

2. Method of Chlorination

a. Tablet Method – Shall NOT be used.

b. Continuous Feed Method – Prior to chlorination, the main(s) and all stub outs, fire hydrants and other appurtenances to the main(s) shall be filled with water and all air shall have be removed. Chlorine shall be fed into the new main(s) on a continuous basis such that the available free chlorine shall be not less than 50 mg/L throughout the entire length of the main(s). Minimum chlorine residual shall be confirmed by sampling at each end of the main(s) plus one sample for every 1200 feet of pipe. Upon successful introduction of chlorine to the minimum concentration, all valves shall be closed such that no water may enter or exit the main(s) being disinfected. Said chlorinated water shall be allowed to sit undisturbed within the main(s) for a period not less than 24 hours. During the aforementioned 24 hour period no additional disinfectant (i.e. chlorine) shall be added to the main(s) at any point. After 24 hours, samples shall be collected

from each of the initial sampling points and each sample shall be checked for free chlorine residual. The residual free chlorine in each of the "24-hour" samples shall be not less than 25 mg/L.

In the event that the residual free chlorine in any of the "24-hour" samples is less than 25 mg/L, the entire main(s), including stub outs, fire hydrants and appurtenances shall be flushed and dechlorinated in accordance with Section 02550, Part 2.07 D. Upon completion of the required flushing, the entire main(s), including stub outs, fire hydrants and appurtenances shall be rechlorinated in accordance with Section 02550, Part 2.07 C.

c. Slug Method - The slug method shall ONLY be used where the total volume of the new water main to be disinfected is greater than 500,000 gallons. When the slug method is used for disinfection, all stub outs, laterals and other appurtenances to the main(s) shall be filled with water and all air shall be removed prior to the commencement of chlorine injection. Chlorine shall be fed into the new main(s) on a continuous basis such that a continuous slug of heavily chlorinated water shall be developed. The available free chlorine residual shall be not less than 100 mg/L throughout the length of the slug. The length of the chlorinated slug shall be not less than twenty (20) percent of the entire length of the main to be disinfected. After the heavily chlorinated slug has been developed, water from the existing water system shall be introduced into the new main to move the slug throughout the entire length of the new main as well as into all stub outs, laterals, and appurtenances. The rate of movement of the slug shall be such that all portions of the new main, including stub outs, laterals and appurtenances shall be in contact with the slug for a period of not less than three (3) hours. As the slug moves through the main, sampling shall occur at each end of the slug and at intervals of not more than 1,000 feet throughout the length of the slug. All sample locations, sample times, and sample results shall be recorded and verification of the minimum three (3) hour contact time shall be provided in a sampling report.

d. If at any time during the disinfection process the free chlorine residual of the slug falls below 75 mg/L, the flow shall be stopped and chlorination equipment shall be moved to the head of the slug. Flow shall resume and additional chlorine applied to restore the free chlorine within the slug to 100 mg/L or more.

D. Removal of Heavily Chlorinated Water

Upon successful chlorination as described in Section 02550, Part 2.07 C, the contractor shall thoroughly flush the new main(s) so as to reduce free chlorine residuals to water system background levels. Flushing of the heavily chlorinated water shall require dechlorination. Hydrogen Peroxide (H_2O_2) shall be used for all dechlorination processes. Sulfur Dioxide (SO2), Sodium Bisulfite (NaHSO3), Sodium Sulfite (Na_2SO_3), and/or Sodium Thiosulfate ($Na_2S_2O_3 \bullet 5H_20$) shall **not** be used.

Note: Hydrogen peroxide (H_2O_2) dechlorination, requires approximately 0.5 lbs of 100% hydrogen peroxide solution to neutralize 1.0 lbs of 100% chlorine. Appropriate adjustments must be made for actual solution concentration of hydrogen peroxide to be used and residual chlorine to be neutralized to obtain necessary hydrogen peroxide feed rates.

The following can be used as a guide for determining necessary feed rates:

H_2O_2 (gal/hr) = (Cl_2 x GPM x 0.003) / % Concentration

Where:

Cl_2 – Free chlorine residual (mg/L) of water to be neutralized
GPM – Flow rate of water (gallons / minute) to be neutralized
% Concentration – Concentration of H_2O_2 used (10% solution is 10 not 0.1)

Gallons of Hydrogen Peroxide (H_2O_2) required to neutralize various residual chlorine concentrations in 100,000 gallons of water.

Free Chlorine	H_2O_2 Concentration		
(mg/L)	**10%**	**15%**	**20%**
	Gallons of H_2O_2 Solution / 100,000 Gallon of Water		
1	0.5	0.33	0.25
2	1	0.67	0.5
10	5	3.4	2.5
50	25	17	12.5

E. Bacteriological Sampling

All bacteriological samples shall be collected by the City's inspector. All bacteriological

testing shall be performed by the City of Savannah Water Supply and Treatment Laboratory. BACTERIOLOGICAL TESTING BY ANY OTHER ENTITY SHALL NOT BE ACCEPTABLE. Results of the bacteriological testing shall be e-mailed or faxed to the City's inspector as soon as they are available. THE LAB SHALL NOT GIVE RESULTS OF BACTERIOLOGICAL TESTING DIRECTLY TO THE CONTRACTOR.

Upon successful completion of proper chlorination/dechlorination in accordance with Section 02550, Parts 2.07 C and 2.07 D, the new main(s) shall be sampled for bacteriological contamination in TWO STAGES as follows:

1. Stage 1 Sampling

   At a minimum, bacteriological samples shall be collected at each end of the new main(s) for mains less than 500 feet in length. Where new main(s) exceed 500 feet in length, but are less than 1200 feet in length an intermediate sample shall be taken. Where new mains exceed 1200 feet in length intermediate samples shall be collected at intervals of no more than 1200 feet along the entire length of the new main(s). Intermediate samples shall be evenly distributed through the main(s) to the extent possible.

Example of Required Number of Sampling and Location

Length of Line	# of Samples	Location of Samples
0 - 500 feet	2	Beginning, End
501 - 1200 feet	3	Beginning, End, 1 Intermediate
1201 -2400 feet	4	Beginning, End, 2 Intermediate
2401 - 3600 feet	5	Beginning, End, 3 Intermediate
3601 - 4800 feet	6	Beginning, End, 4 Intermediate
4801 - 6000 feet	7	Beginning, End, 5 Intermediate

In the event that Stage 1 bacteriological testing fails the contractor may re-flush the main(s) in accordance with section 02550, Part 2.07 B and collect a ONE TIME ONLY re-sample of the Stage 1 bacteriological samples. If the Stage 2 bacteriological samples are collected before the results of the failed Stage 1 samples are received by the City's inspector those samples become the resample of the Stage 1 sampling and the opportunity to flush without re-chlorinating is forfeited. Therefore, it is

strongly recommended not too begin the Stage 2 sampling until confirmations of acceptable Stage 1 sampling results have been obtained.

2. Stage 2 Sampling

Not less than 24 hours following the collection of the Stage 1 bacteriological sample(s) a second set (Stage 2) of bacteriological samples shall be collected from the same sampling points as the Stage 1 bacteriological sampling. The main(s) being disinfected shall be ABSOLUTELY UNDISTURBED; this means NO FLUSHING OR OTHER USE OF WATER, between Stage 1 and Stage 2 samplings.

Bacteriological tests shall be failed as follows:

a. Where bacteriological tests indicate too much trash exists within the sample.
b. Where more than ten (10) non-coliform bacteria are found in any tested sample.
c. Where any coliform bacteria are found in any tested sample.
d. In the event that lab personnel have suspicion that the samples and or test results are not of sufficient quality to warrant acceptance.

F. Disinfection and Bacteriological Phasing of New Mains

The new main(s) to be sampled shall be considered as a single unit such that failure of a single bacteriological sample shall constitute a failure of the entire new main(s). Where new mains are being chlorinated and tested in phases, each phase shall be considered as a single unit and the failure of one phase shall not impact the acceptance or failure of any other phase. However, phasing of a system of new mains, or phasing of a single long main shall be established prior to the commencement of disinfection and shall proceed in geometric order beginning at the existing water system, such that water from an untested or failed phase shall not pass through a phase which has been accepted.

2.08 DISPOSAL AND TREATMENT OF HEAVILY CHLORINATED WATER

A. The waters and/or environment into which the chlorinated water is to be discharged shall be inspected and analyzed. If there is any possibility that the chlorinated discharge will cause damage to the environment, the chlorinated water may be discharged by either of the following two (2) methods:

1. Should a City of Savannah Sanitary Sewer manhole be in the vicinity and after confirmation and approval of the City of Savannah Water Quality Department, the chlorinated water may be discharged into the manhole.

2. A neutralizing chemical shall be added to the discharge water to neutralize thoroughly or decrease the chlorine residual to less than 0.5 mg/L. Refer to Section 02550, Part 2.07 D for the information on the chemical requirements. In cases where lower chlorine residual is required by environmental permit, more neutralizing chemical may be required to further lower the residual chlorine levels in the discharge.

B. Containers

Depending on the chemical used for dechlorination, the storage containers will vary from gas cylinders, liquid in 50 gallon (190 L) drums, or dry compounds. Dilution tanks and mixing tanks will be required when using dry compounds and may be necessary when using liquid compounds to deliver the proper dosage. Solution containers should be covered to prevent evaporation and spills.

C. Mixing and Contact Requirements

Concentrated hydrogen peroxide shall be diluted prior to use. Mix the concentrated hydrogen peroxide into potable solution water in a well ventilated area. Always add hydrogen peroxide to water, NOT water to hydrogen peroxide.

The reaction is rapid at alkaline pH and the dechlorination rate is directly proportional to the concentrations of free chlorine and hydrogen peroxide, e.g. – at a starting pH of 7 and 2 mg/L of free chlorine, the reaction is over within 3 minutes using 5% excess hydrogen peroxide.

Field testing shall be performed (to the satisfaction of the City) to determine the contact time required for dechlorination of the heavily chlorinated water prior to discharge. The dechlorination system shall be large enough to provide a contact time of 120% of the experimentally determined contact time. Adequate mixing shall be provided, either by mechanical means or hydraulic turbulence.

D. Sampling and Control

City personnel will be responsible for the collection of water samples from new water lines or systems.

A minimum of 48 hours notice prior to chlorination/dechlorination (where required) shall be required for the contractor to contact the City Water Supply & Treatment at 912-351-3434, so Water/Sewer may schedule the collection of the required sample(s). For Private Development projects, contractors shall contact the City Engineer's office at 912-651-6510.

Facilities shall be included for sampling the dechlorinated effluent for residual chlorine. When using hydrogen peroxide for dechlorination, use an ortho-tolidine test method to check the chlorine residual. Unlike other chlorine test methods, the presence of excess hydrogen peroxide does not interfere with the ortho-tolidine method.

2.09 EXISTING SYSTEM

The existing water distribution system in service shall be kept in service until the new system has been constructed, sterilized, and accepted by the City of Savannah Water and Sewer Bureau.

2.10 GRASSING

All disturbed areas shall be grassed in accordance with Section 02485 "GRASSING" unless otherwise indicated.

PART 3 - TESTING

3.01 HYDROSTATIC TESTS

A. The new main(s), including stub outs, laterals, fire hydrants, and appurtenances shall be hydrostatically tested to a minimum of 150 psi at the highest point of the main(s) for a period of not less than 2 hours in accordance with ANSI/AWWA C600. In the event that a pressure gauge cannot be placed at the highest point of the new main(s) the test pressure at the gauge shall be increased by 1 psi for every 2.31 feet of rise between the elevation of the gauge and the elevation of the highest point of the new main(s).

B. A maximum loss of 3 psi will be allowed during static testing. The contractor shall notify the City inspector not less than 48 hours (2 working days) prior to applying pressure for testing. Pressure tests shall be witnessed by the City's inspector. A LEAKAGE RECOVERY TEST WILL NOT BE ACCEPTABLE.

3.02 COMPACTION TESTING

Laboratory tests of the soil shall be made in accordance with ASTM D-698. In-place density tests shall be made in accordance with ASTM D-1556 or D-2922. Results of the tests shall be furnished to the Engineer by the testing laboratory.

A. The minimum number of tests required for backfill over water in traffic area shall be 1 per 100 LF for each 4 feet of depth or portion thereof.

B. The minimum number of tests required for backfill over water in non-traffic areas shall be 1 per 200 LF for each 6 feet of depth or portion thereof.

END OF SECTION 02550

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SECTION 02554

WASTEWATER COLLECTION SYSTEM

PART 1 - PRODUCTS

Material and equipment used in the work shall conform to one of the following:

1.01 SEWER PIPE

A. PVC Pipe for Gravity Sewer - Shall be SDR 26 polyvinyl chloride plastic and shall meet all requirements of the ASTM D-3034 for diameters 4" through 15", latest revision or ASTM F679 for diameters 18" through 48", latest revision. PVC pipe shall be installed in accordance with ASTM D-2321, latest revision. All pipes shall be suitable for use as a gravity sewer conduit and shall be green in color. Provisions must be made for contraction and expansion at each joint with a rubber ring. Standard laying lengths shall be fourteen (14) feet or twenty (20) feet, ± 1-inch, for all sizes. Fittings shall meet the same specification requirements as the pipe.

Tests on PVC Pipe - Shall be designed to pass all tests at 73° F. (± 3° F.)

B. PVC Pipe for Force Main

PVC Pipe - Plastic pipe shall be PVC SDR 18, C-900 for 12-inch and smaller and SDR 18, C-905 for 14-inch and larger. All pipe shall conform to ASTM D-2241 and be installed in accordance with ASTM D-2321.

Pipe shall bear the National Sanitation Foundation seal of approval and shall comply with the requirements of Type I, Grade I (PVC 1120) of the ASTM resin specification D-1784. Certificates of conformance with the foregoing specifications shall be furnished with each lot of pipe supplied.

PVC pipe for force mains shall be green in color, and shall be furnished in nominal 18 to 20 foot laying lengths unless otherwise noted.

C. Ductile Iron Pipe – Standard Coating

Buried piping and exposed piping not subject to highly corrosive environments shall conform to AWWA C-150, AWWA C-151 and ASTM A-746 latest revisions. All pipes shall be thickness Class 50 unless otherwise noted.

1. Exterior Coating

   a) All buried ductile iron pipes and fittings shall receive an exterior bituminous coating approximately 1 mil thick. The finished coating shall be continuous, smooth, neither brittle when cold or sticky when exposed to the sun, and shall be strongly adherent to the iron.

   b) All exposed ductile iron pipes and fittings shall receive an exterior coating of Tnemec Series 431 Perma-Shield polyamine ceramic epoxy, (unless otherwise specified by the Engineer or subject to conditions described in 1.01 D below). Pipe surface shall be prepared by uniform rotary-abrasive blasting using angular abrasive to an NAPF 500-03-04, 3-mil anchor profile. Fitting surface shall be prepared by uniform rotary-abrasive blasting in accordance using an angular abrasive to an NAPF 500-03-05, Blast Clean #1 condition, 3-mil anchor profile. Pipe surfaces shall receive 3-5 mils dry film thickness (DFT) of Tnemec Series 140 Pota-Pox Plus epoxy primer, 30-40 mils DFT Tnemec Series 431 Perma Shield PL polyamine ceramic epoxy. To prevent UV damage, apply 3 mils DFT Tnemec Series 72 Acrylic Urethane.

2. Interior Lining - The interior of all ductile iron pipes and fittings shall be lined with Protecto 401 ceramic epoxy, unless indicated otherwise.

   a. Protecto 401 - Protecto 401 Ceramic Epoxy interior lining shall be 40-mils dry film thickness (DFT) and conform to Permeability rating ASTM E-96-80, Salt Spray ASTM B-117-09, Cathodic Disbondment ASTM G6-95, and Immersion Testing ASTM D-714-02. Interior lining shall not be applied below 40° F. Lining shall not be used on the face of the flange.

   b. Gasket / Spigot Ends - Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum DFT of Protecto 401 Joint Compound. The joint compound shall be applied by brush to ensure coverage. Care should be taken that the joint compound is smooth without excess buildup in the gasket seat or on the spigot ends.

D. Ductile Iron Pipe – Exposed High Corrosion Applications

Piping exposed to highly corrosive conditions inside sanitary pumping station wet wells and dry pits, sanitary air release valve manholes, or as directed by the Engineer, shall

conform to AWWA C-151, AWWA C-115 latest revisions. Piping shall extend through the structures, (wetwell, dry pit, ARV manholes). All pipes shall be thickness Class 53 unless otherwise noted.

1. Exterior - A Zinc/Epoxy exterior coating system comprised of zinc spray metalizing, and Tnemec Series 431 Perma Shield PL ceramic epoxy coating shall be applied to pipe exterior. Immediately after annealing, all DIP shall receive zinc spray metalizing. The resultant mean mass of zinc shall not be less than 130 g/m^2 and shall be applied throughout the entire length of the pipe. The zinc coating shall be brush off abrasive blasted to scarify the surface. The pipe shall receive a prime coat of series N140-1255 primer applied at 3-5 mils DFT, and then receive a top coat of Series 431 Perma Shield PL per Tnemec's recommendations. The top coat shall be nominal 30-40-mils thick and adequately cover all exposed areas.

2. Interior – Interior pipe surfaces shall receive a nominal 40-50 mils dry-film thick coat of Tnemec Series 431 Perma Shield PL ceramic epoxy coating covering all interior surfaces. The surface shall be prepared by abrasive blasting in accordance with NAPF 500-03-04.

3. Fittings – All exposed fittings used in high corrosion applications shall receive a nominal 30-40 mils dry-film thick coat of Tnemec Series 431 Perma Shield PL ceramic epoxy coating covering all interior and exterior surfaces, with the exception of the flange faces which shall receive a 3-5 mil nominal coat of Tnemec N140 primer. The surface shall be prepared by abrasive blasting in accordance with NAPF 500-03-05.

The finished coatings shall be holiday free when high-voltage holiday tested to 4000 volts per ASTM standards. All surface prep shall be per Tnemec's recommendation which include proper grinding and blasting to ensure a 3-mil anchor profile is achieved throughout the area to be lined. Approved applicators include Electrosteel USA.

E. Interior Lining / Exterior Coating Repair

Any linings or coatings damaged in the field shall be repaired by power tool cleaning to bare metal (SSPC-S11) and touched up using manufacturer's field repair kit to a 40-mil nominal coating. The City reserves the right to reject piping or fittings due to field or shipping damage of the protective coating system.

F. Lining / Coating Applicator Certification

Lining application, inspection, certification, handling and surface preparation of the area to receive the protective coating shall be in accordance with the manufacturer's specification and requirements. Supplier shall engage a single installer (or one installer for pipe and a second for fittings) approved by the manufacturer with a minimum of three years' experience performing this type of lining installation and with documented skill and successful experience in the installation of ceramic epoxy lining to interior of ductile iron pipe and fittings. Contractor shall provide a Letter of Certification to the Engineer or City Inspector from the lining manufacturer indicating that the lining installer meets all of the manufacturer's quality assurance and quality control requirements, (Qualified Applicator).

1.02 SEWER PIPE JOINTS

A. Gravity Sewer Pipe

1. Joints for PVC Pipe - Shall be integral wall bell and spigot with a rubber ring gasket. The joints shall conform to ASTM D-3212 latest revision and the gaskets shall conform to ASTM F-477 latest revision.

2. Joints for Ductile Iron Pipe - Shall comply with the requirements of 1.02 B.2.

B. Force Main Pipe

Joints shall be in accordance with ASTM D-3036. All PVC fitting must have NSF-61 approval and must comply with, or exceed AWWA C907. Saddle type fittings shall not be used.

1. Plastic pipe shall be joined by means of a rubber ring bell joint which shall be an integral part of the barrel or solvent welded at the factory. The joints shall have a space to provide expansion and contraction of the pipe without leaking. Fittings for plastic pipes shall be PVC with ring tightened rubber joints; or ductile iron with adapters to PVC pipe. Pipe shall be manufactured to ductile iron pipe equivalent outside diameter.

   The bell shall consist of an integral wall section with a bonded-in solid cross section elastomeric ring which meets the requirements of ASTM F-477 and ASTM D-3139. The bell section shall be designed to be at least as hydrostatically strong as the pipe wall and meet the requirements of C900-07 or C905-10.

Each standard and random length of pipe shall be tested to two times the rated pressure of the pipe for a minimum of five (5) seconds. The integral bell shall be tested with the pipe.

2. Ductile Iron Joints – For various applications shall meet the below criteria:

   a. Flanged Joints: Shall conform to ANSI Specification 21.2(AWWAC–150). Flanges shall be Class 125. Gaskets for flanged pipe and fittings shall be 1/16-inch ring gasket of red sheet rubber. Bolts and bolt studs shall conform to ANSI Specification B 16.1 (AWWA C-153).

   b. Mechanical Joints: In cast and ductile iron pipe shall conform to ANSI Specification A 21.11 (AWWAC-111). All glands shall be made of ductile iron only.

   c. Push-On Joints: Shall have a rubber gasket that fits into a retainer recess in the bell and produces a watertight joint when the spigot is pushed home.

   d. Restrained Joints - Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to "Mega-Lug" or push-on type joints equivalent to "Lock-Ring," "TR Flex", or "Super Lock" and shall have a minimum rated working pressure of 250 psi. Mechanical joint retainer glands shall comply with the manufacturer's specifications for the pipe material (ductile iron vs. PVC). The joints shall be in accordance with the applicable portions of ANSI/AWWA C111/A21.11. The manufacturer of the joints shall furnish certification, witnessed by an independent laboratory, that the joints furnished have been tested at a pressure of 500 psi without signs of leakage or failure. All wedge assemblies and related parts of restraint devices shall be processed through an iron-phosphate spray, rinse and drying operation in preparation for coating application. The coating shall consist of a minimum of two coats of liquid Xylan® fluoropolymer coating with heat cure to follow each coat. All casting bodies of restrained joints shall be surface pre-treated with an iron-phosphate spray, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. The coating shall be a polyester based powder to provide corrosion, impact and UV resistance. The coating system shall be Mega-Bond™ by EBAA Iron, or Star-Bond by Star Products. Restrained joints shall be capable of being deflected after assembly. Restrained joints shall have a preset deflection of no more than 5° and shall be able to take up 3° of deflection after burial.

e. Couplings - All connections of new sewer pipe to existing sewer pipe shall use rigid couplings. Flexible (e.g. Fernco) couplings shall not be allowed. Couplings shall be PVC double bell type, ductile iron mechanical joint solid sleeve type or ductile iron straight and transition type (e.g., Dresser Couplings) depending on the application.

C. Ductile Iron Fittings

Fittings shall consist of bends, tees, crosses, caps and plugs, reducers, tapped tees, sleeves, etc. All fittings furnished shall be cast and machined at one foundry location to assure quality control and provide satisfactory test data. Fittings shall have cast on them the pressure rating, nominal diameter of openings, manufacturer's name, foundry location, plant code, and degrees of fraction of the circle. Cast letters and figures shall be on the outside body of the fitting. Ductile iron welded on outlets is not acceptable.

1. Fittings for Push-On and Mechanical Joint Pipe shall be ductile iron, manufactured in accordance with ANSI A21.10 (AWWA C-110) or ANSI A21.53 (AWWA C-153) standards. Fittings shall be designed to accommodate the type of pipe used.

2. Fittings for Flanged Pipe: Shall be manufactured in accordance with ASNI B16.1, Class 125 flanges. Bolt circles and bolt holes shall also meet ANSI B16.1.

1.03 AIR RELEASE VALVES

A. General

Air Release Valves (ARV's) shall be provided as required by the Engineer, who shall specify ARV type (or function), size, and location. The combination air and vacuum release valves (CAV's) specified below are suitable for most forcemain applications.

The specification of these CAV's below does not relieve the Engineer of the responsibility to select (and locate) ARV's for proper forcemain operation and long-term durability. ARV selection shall be in accordance with AWWA Manual of Water Supply Practices M51 - Air-Release, Air/Vacuum & Combination Air Valves, the manufacturer's published information, and the Engineer's experience.

The manhole and installation of the two-inch valve shall be in accordance with the City of Savannah Standard Construction Detail S-11. Prior to deciding on the location of any air release valve, the Contractor shall provide the Engineer with an accurate profile of the installed force main so that high points in the system can be determined. The

locations of the air release valves shall be field adjusted based on the locations of the high points.

B. Combination Air Release / Air Vacuum Valves (CAV)

CAV shall be equipped with dual orifices. The small orifice (air release) shall allow entrapped air to be released under pressure. The large orifice (air/vacuum) shall discharge large amounts of air during filling of the line as well as admitting large amounts of air into the system during drainage or in response to water column separation.

CAV shall be comprised of 100% non-corrosive materials. Epoxy-coated materials will not be allowed. The valve upper body, base, and threaded or flanged inlet shall be made from 316 Stainless Steel.

CAV shall be of dual-float design in order to maintain an air gap which keeps liquids, grease and debris away from the sealing part of the valve.

CAV sealing mechanisms shall be either by EPDM rolling seal or Buna NBR roll-on diaphragm. All wastewater CAVs shall come with a full 5-year manufacturer's warranty to repair or replace valve if damage is due to manufacturer defect.

CAV shall have an operating pressure range from 1 to 250 psi.

1. Two (2) inch CAV shall be 2" NTP standard. Acceptable manufacturers and models include ARI, USA Model D-025-LTSS-02, H-TEC Model 986-T-02-SS, or pre-approved equal.

2. Four (4) inch CAV shall be class 125 flanged. Acceptable manufacturers and models include ARI, USA Model D-020-SS-04, H-TEC Model 986-F-04-SS, or pre-approved equal.

Valves shall be equipped with the necessary attachments, including 1" 316 SS ball valve and 1.5" camlock fitting to permit back flushing after installation without dismantling the valve.

1.04 MANHOLES

A. Precast Concrete – The minimum wall thickness for precast manholes shall be five (5) inches for 4-foot ID manholes and seven (7) inches for 6-foot ID manholes. Cone

sections shall have a minimum wall thickness of eight (8) inches at their top. Manholes shall be manufactured with 4,000 psi concrete, type II cement that meet ASTM C-150 and absorption shall not exceed 6%. Wall reinforcement shall meet ASTM C-478 and also have a No. 4 rebar hoop around each pipe opening. The flat top slab sections shall handle HS-20 traffic loadings. Bottom slabs shall be six (6) inches thick and be reinforced with No. 4 rebar at nine (9) inch O.C.E.W. All items shall be wet cast. Dry casting or low slump concrete will not be allowed. All bases will have proper lifting hooks in the bottom slabs (min. of 3) and there shall be no penetrating lifting holes on any structures. No holes will be allowed within six (6) inches of any joint on structures. All manholes shall be coated as per Section 02555.

Manhole sections shall be free from large honeycomb, cracks, spalls, large chips, exposed reinforcing, and broken bells and spigots. Edges of bells and spigots shall be even and straight.

It shall be the responsibility of the Contractor to insure that the manhole(s) are designed properly for the loading conditions as indicated on the plans. Should the loading conditions require greater structural integrity than the minimum, as herein specified, it shall be the responsibility of the Contractor to utilize a structural design of greater strength.

Joints – A liquid butyl primer shall be applied by the precast manufacturer to all interior and exterior surfaces per City of Savannah Section 02555 - "Protective Coating for Existing and New Concrete and Masonry Sanitary Sewer Structures." Flexible plastic gasket shall be placed on each of the three joint faces. Gasket shall be RAM-NEK or approved equal. The exterior of all joints shall be wrapped with a butyl rubber wrap ConSeal CS-212, or approved equal. Wrap shall have a minimum thickness of 65 mils and minimum width of 8". All joint sealant materials shall be applied to clean, dry surfaces and as recommended by the manufacturer. All joint sealant materials shall attach firmly to the concrete surfaces without the use of additional adhesives, tape, or other fastening devices.

Precast concrete manholes shall be manufactured at plants certified by the National Precast Concrete Association. All Manholes shall be pre-cast concrete, unless authorized by the sanitary sewer Conveyance Department.

B. Ring and Cover - Manhole ring and cover shall be gray cast iron per ASTM A48, Class 35B without perforations and suitable for addition of cast iron or steel rings for upward adjustment of top. The words "CITY OF SAVANNAH SANITARY GEORGIA" shall be cast

into the face of the cover in 1.5-inch to 2-inch letters raised flush with the top of the cover. Ring and cover shall have machine ground seats and be an approved equal to model V1327-1 RG V1327GS EPIC SAVANNAH SN as manufactured by E.J. All manhole rings and covers shall be made water resistant by means of dovetail grooves and gaskets in the cover. Provide circular cover weighing not less than 138 pounds with two (2) pick slots for removing cover spaced at 180°. No stacking lugs shall be allowed.

Proof Load Testing: Traffic service castings shall have a first article proof load test conducted and the results of that proof load test shall be made available to the City upon request. The proof load test shall be conducted in accordance with the methods and procedures outlined in AASHTO M306-10, Section 6, Proof Load Testing. The casting shall be tested on a suitable and calibrated load testing machine and the casting shall hold a 40,000 pound proof load for one minute without experiencing any cracks or detrimental permanent deformation.

Grade Adjustment – Expanded polypropylene grade adjustment rings shall be used to bring manhole ring and cover to within 1/4" to 1/2" of flat or sloping finished grade. Grade adjustment rings shall be capable of supporting AASHTO H-25 and HS-25 loads, shall be UV stable, resistant to chemicals and corrosion commonly associated with sanitary sewer environments, and shall have a minimum fifty (50) year design life. Rings shall have a tongue and groove design for vertical stacking up to 12". Rings shall be joined to manhole cone, other rings, and manhole frame and cover with a watertight adhesive sealant. Grade adjustment rings shall be Cretex Pro-Ring, or approved equal. Watertight adhesive sealant shall be M1 Structural Adhesive/Sealant, or approved equal.

In non-traffic areas, traditional brick and mortar grade adjustment is allowed. In these instances, an external manhole chimney seal shall be required. External chimney seal shall be the model X-85 as manufactured by Cretex, or approved equal. Top of manhole cone shall have a minimum vertical sealing surface of 3" that is smooth and free of any form offsets or excessive honeycomb.

C. Pipe Connections - Pipe/manhole connector shall be one piece rubber boot secured to pipe with stainless steel clamp band and to the manhole with stainless steel expansion ring. Acceptable pipe connector would be Kor-N-Seal Boot, A-lock or equal. Space between pipe connector and pipe OD shall be filled with non-shrink grout.

D. Manhole Steps – Manhole steps shall be provided at 16-inches O.C. for manholes greater than four (4) feet deep. Steps shall have impact resistant co-polymer

polypropylene plastic molded around ½" diameter, grade 60 reinforcing steel. Manhole steps shall be M.A. Industries PS1-PF reinforced plastic step complying with the requirements of ASTM C 478, or approved equal.

1.05 CASING AND CASING SPACERS

A. Casing pipe shall be steel conforming to ASTM A-139 latest revision, minimum yield strength point of 35,000 psi, and of the diameter and thickness shown on the contract drawings at each crossing. The pipe ends shall be tapered where welding is required. Full pipe lengths shall be provided. No pipe casing lengths less than eight (8) feet shall be allowed unless approved by the Owner. All casing welds shall be continuous and made by a certified welder.

For casing pipe crossings under roadways/railroads, the Contractor shall comply with the regulations of said authority in regard to design, specifications, and construction. State highway casing installations shall be as specified in the GDOT, "Utility Accommodation Manual," and for railroads, the American Railway Engineering and Maintenance-of-Way Association (AREMA) manual for Railway Engineering, Chapter 1, Part 5, Section 5.3, "Specifications for Pipelines Conveying Non-Flammable Substances," shall be applicable.

Where allowed by the affected utility owner(s), fusible PVC casing may be used with fusible PVC carrier pipe for sanitary force mains. The design engineer shall calculate the appropriate piping dimension ratio (DR) for fusible PVC casing considering earth, live, and groundwater, service loads and pullback forces.

Use of PVC casing shall require the use of rubber boots for end seals. End seals shall be neoprene with 304 SS banding clamps as manufactured by Cascade CCES, or approved equal. End seals shall be installed per manufacturer's recommendations, to include casing spacer spacing to provide adequate reinforcement at end of casing pipe.

All carrier pipes shall be restrained joint ductile iron or fusible PVC.

B. Casing Spacers shall be bolt on style with a shell made in two (2) sections of Heavy T-304 Stainless Steel. Connecting flanges shall be ribbed for extra strength. The shell shall be lined with a PVC liner. All nuts and bolts shall be 18-8 Stainless Steel. Runners shall be made of Ultra High Molecular Weight Polymer with inherently high abrasion resistance and a low coefficient of friction. Runners shall be supported by risers made of Heavy T-304 Stainless Steel. The combined height of the supports and runners shall keep the

carrier pipe a minimum of 3/4-inch from the casing pipe at all times. Installation and spacing of casing spacers shall be as required by the manufacturer. Casing Spacers shall be as manufactured by Cascade Waterworks Manufacturing Company, or approved equal.

Casing spacers for fusible PVC carrier pipe should be of a projection type that has a minimum number of projections around the circumference that total the number of diameter inches. For example: 8" pipe should have a minimum of 8 projections and 18" pipe should have a minimum of 18 projections. Spacing between spacer rings (span) should be calculated based on the actual installed load (weight of pipe filled with liquid) but should not exceed 10 feet. Refer to the manufacturer's tables for the load carrying capacity of each type of spacer used. Casing spacers should be projection type – non metallic spacers constructed of preformed sections of high-density polyethylene. Spacers should be ISO 9001:2000 certified for strength and quality. Casing spacers should be installed using double backed tape provided with the spacers in order to fasten them tightly to the carrier pipe. Casing spacers for fusible PVC carrier pipe shall be as manufactured by Raci North America, or approved equal.

1.06 SANITARY SERVICE LATERAL CONNECTIONS

A. Tee-wyes shall be a minimum of four (4) inches and shall be the same diameter as the run of the pipe. They shall be of the same material as the sewer main. Tee-wyes shall be used for all service connections to new sewer main.

B. Service Saddles: Service Saddles shall be flexible sewer saddles with double stainless steel straps or PVC Inserta Tees^{TM}. Service Saddles shall only be allowed for new service connections to existing sewer mains.

1.07 SANITARY SERVICE LATERALS

A. Laterals shall be either ductile iron with push-on joints, conforming to Paragraphs 1.01.C and 1.02.B.2, or SDR 26 Polyvinyl Chloride with bells and natural rubber rings for jointing, conforming to Paragraphs 1.01.A and 1.02.A.1.

B. A saw cut "S" shall be cut in the top of the curb directly over the lateral location. Tracer wire shall be adhered to the lateral from the main and up to the cleanout.

1.08 METAL DETECTOR TAPE

Detector tape shall be installed over all nonmetallic gravity sewers. The tape will be

equivalent to Terra-Tape by Griffolyn Co., Inc. of Houston, Texas. The tape shall be at least two (2) inches wide, green in color, and be labeled "Caution Buried Force Main Below" or "Caution Buried Sewer Line Below" on the tape in black letters. The tape shall have a tensile strength of not less than 4,000 psi, dart impact strength of not less than 120 grams per 1.5 mils, be not less than 0.0055 inches thick, and include sufficient metal to allow easy detection from above ground. The detector tape shall be designed to last as long as the pipe it is installed over, even in adverse soils.

1.09 TRACER WIRE AND CONNECTORS

A. Tracer Wire

Tracer wire shall be installed on all force mains, with direct burial connectors, and provide continuous electrified conductivity. Area markers shall be at least every 500 feet with tracer wire attached, unless a manhole is available. A six (6) foot lead attached to the inside of the ring and cover shall be provided at manholes. On laterals, the tracer wire shall connect the clean-out to the gravity sewer.

1. Tracer wire shall be copper clad steel with high-density, high molecular weight polyethylene (HDPE) insulation, and rated for direct burial use at 30 volts. Conductor must meet 21% conductivity for locate ability purposes. HDPE insulation shall be RoHS compliant and utilize virgin grade material. Insulation color shall meet the APWA color code standard for identification of buried utilities.

2. Tracer wire for direct burial shall be a #12 AWG HS-CCS high-strength copper clad steel conductor (HS-CCS), insulated with a 30 mil, HDPE insulation. Minimum break load shall be 380 lbs. Wire must be installed in the 3 o'clock position during installation. Tracer wire shall be Boar Tough High Strength CCS PE30 UL by Agave Wire Ltd or Copperhead HS-CCS HDPE 30 MIL or Pre-Approved Equal.

3. Tracer wire for directional drilling/boring shall be #12 AWG extra-high-strength copper clad steel conductor (EHS-CCS), insulated with a 45 mil, HDPE insulation. Minimum break load shall be 1,150 lbs. Tracer wire shall be Boar Tough Extra High Strength by Agave Wire Ltd, Copperhead EHS-CCS HDPE 45 MIL or Pre-Approved Equal.

B. Connectors

1. Wire connectors shall be UL 486D listed, one-piece direct bury twist-on type, UL

designation MDB, sealed wire connectors. Max voltage shall be 600 Volts. Connectors shall be rated to 105° C and sized to accommodate a minimum of four (4) #12 copper / steel core tracer wires. Silicone sealant shall be rated for temperatures from -45° F to 400° F. Connector shall be DryConn King 6 Blue by King Innovation, or pre-approved equal.

2. Spliced connectors shall be direct bury design, with a maximum voltage of 50-volts. Spliced connectors shall have a tin plated high conductivity aluminum lug, zinc-plated steel screws, high-impact polypropylene housing, and a non-hardening viscous dielectric silicone sealant. Silicone sealant shall be rated for temperatures from -45° F to 400° F. Spliced connector shall be DryConn Direct Bury Lug Aqua, or pre-approved equal.

C. Area Markers – Utility marker posts equal to Rhino TriView Plus Test Station shall be installed every 500-foot along force main mains. Posts shall be marked as "Sanitary Sewer Force Main".

1.10 FORCE MAIN SUBSURFACE MARKERS

Omni-balls or equal shall be installed above force main pipe at all bends, and at least every 500-foot along straight pipe runs. Depth of burial shall be a minimum of 2' below finished grade and no greater than 3' below finished grade.

1.11 CONCRETE VALVE MARKER POSTS

Concrete valve marker posts shall be furnished and installed as indicated on the construction plans, typically in undeveloped areas or areas not routinely cleared. Place markers as directed by Engineer and set a minimum of 18-inches above finished grade.

The marker post shall be at least 42" long, have a minimum 4"x 4" square cross section, beveled edges, and at least one 3/8" diameter bar of reinforcing steel. The exposed section of the marker shall have 3" tall letters spelling "SAV" (sanitary air valve) or "STV" (sanitary tapping valve) cast into two (opposite) sides of the marker. Marker shall be painted with two coats of green paint, with care taken to not paint the inset letters.

1.12 POLYETHYLENE ENCASEMENT

Polyethylene encasement shall be used on all ductile iron piping, and shall be in tube form conforming to the requirements of ANSI/AWWA C105/A21.5 latest revision. The polyethylene film shall have the following characteristics:

Tensile Strength:	1,200 psi minimum
Elongation:	300 percent minimum
Dielectric Strength:	300V/mil thickness minimum
Thickness:	Nominal thickness of .008 inch (8 mil)

1.13 BEDDING AND BACKFILL

A. Classification of Materials – ASTM D-2321 classifies soils using the Unified Soils Classification System (ASTM D-2487). For the purpose of this specification, soils to be used as backfill material are grouped into five classes according to soil properties and characteristics.

1. Class I - Angular, 1/4 to 1-1/2 inch graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, crushed gravel, and crushed shells.

2. Class II - Coarse sands and gravels with maximum practical size of 1-1/2 inch, including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class.

3. 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. These materials are not to be used for bedding or haunching.

4. 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 are not to be used for bedding, haunching, or initial backfill.

5. Class V - This class includes the organic soil, OL, OH, PT as well as soils containing frozen earth, debris, rocks, larger than 1-1/2 inch in diameter, and other foreign materials. These materials are not to be used.

B. Stone Bedding - Stone used for foundation, bedding, and haunching shall be shall be crushed stone or gravel conforming to ASTM C33, size #57, with size range of ¼ to 1-inch, free from debris, roots, trash, stones, or other harmful substances.

C. Backfill – Whether imported borrow material or from on-site excavations, backfill shall be suitable Class II or Class III material. Backfill material shall be free from debris, roots, trash, stones, or other harmful substances. Suitable soils are those complying with

ASTM-2487 soil classification groups GW, GP, GM, SW, SP, and SM.

1. Common Backfill

   Common backfill shall consist of mineral soil, substantially free of clay, organic material, loam, wood, trash, and other objectionable material which may be compressible or which cannot be compacted properly. Common backfill shall not contain stones larger than 6 inches in any dimension, asphalt, broken concrete, masonry, rubble, or other similar materials.

   The backfill shall have physical properties such that it can be readily spread and compacted during filling. Additionally, common backfill shall be no more than 12 percent by weight finer than the No. 200 mesh sieve unless finer material is approved for use in a specific location by the City.

   Material falling within the above specifications, encountered during the excavation, may be stored in segregated stockpiles for reuse. All material which, in the opinion of the Engineer, is not suitable for reuse on the site shall be removed and disposed of by the Contractor.

2. Select Backfill

   Select backfill fill shall be as specified above for common backfill, except that the material shall contain no stones larger than 1-1/2 inches in largest dimension, and shall be no more than 5 percent by weight finer than the No. 200 mesh sieve.

3. Borrow Material

   Where it is determined that sufficient suitable material is not available from the site to satisfactorily backfill the pipe to at least two (2) feet above the top of the pipe, suitable borrow material meeting the requirements of this specification, unless otherwise noted, shall be provided by the Contractor from other sources at Contractor's expense. All material from the excavation unsuitable for bedding, backfill, or other uses as directed by the Engineer and approved by the Owner, shall be removed and disposed of by the Contractor.

1.14 PRODUCT REVIEW

The Contractor shall provide the Engineer with a complete description of all products before ordering. The Engineer shall review and approve all products before they are

ordered.

PART 2 – EXECUTION

2.01 USE OF STANDARD CONSTRUCTION TECHNIQUES

A. Responsibility for Proper Construction - The standard construction techniques presented herein for bedding, backfill, and compaction are suitable in areas of favorable soils. However, the ENGINEER SHALL REMAIN RESPONSIBLE FOR CONDUCTING ON-SITE SOILS INVESTIGATIONS appropriate for the nature of the project at hand. The ENGINEER SHALL REMAIN FURTHER RESPONSIBLE for providing the procedures and details necessary for proper gravity sewer or forcemain installation throughout the entire project corridor.

B. Minimum Site Soils Investigation Requirements - All projects requiring the installation of any water or sanitary pipe other than service laterals shall require a minimum of one (1) soil boring every 300 linear feet along the proposed utility corridor. Borings shall be to a depth of two (2) feet deeper than the deepest proposed line within 150 feet. A Geotechnical Report, identifying the type(s) of soils found on the project site shall be provided with the construction plan submittal. The report shall include, at a minimum, boring logs, (types of soils encountered, e.g. - type GW, GP, SW, SP, etc., depths of soil types, observed groundwater, seasonal high groundwater, etc.), and any special requirements for pipe bedding, backfill, or compaction. The location of the boring(s) shall be clearly shown on the construction plans.

C. Use of Standard Procedures and Details - If site-specific procedures or details for bedding, backfill, compaction, and joint restraint are not provided in the contract documents and the Engineer includes only the standard City of Savannah specifications and details for pipe bedding and joint restraints, the ENGINEER IS ATTESTING THAT SOIL CONDITIONS ARE FAVORABLE, and that the STANDARD METHODS ARE ACCEPTABLE based on the soil conditions observed and the Engineer's experience.

2.02 CONSTRUCTION OBSERVATION

The line, grade, deflection and infiltration of sewers shall be tested by the Contractor under the direction of the Engineer. The Engineer will have the right to require that any portion of the work be done in his presence and if the work is covered up after such instruction, it shall be exposed by the Contractor for observation. However, if the Contractor notifies the Engineer that such work is scheduled and the Engineer fails to

appear within 48 hours, the Contractor may proceed without him. All work done and materials furnished shall be subject to review by the Engineer or Project Representative. Improper work shall be reconstructed. All materials which do not conform to the requirements of the specifications shall be removed from the work upon notice being received from the Engineer for the rejection of such materials. The Engineer shall have the right to mark rejected materials so as to distinguish them as such. The Contractor shall give the Project Engineer or Project Representative a minimum of 48 hours notice for all required observations or tests.

2.03 LOCATION AND GRADE

The line and grade of the sewers and the position of all manholes and other structures are shown on the drawings. The grade line as given on the profile or mentioned in these specifications means the invert or bottom of the inside of the pipe. The price for trenching shall include the trench for the depth below this line necessary to lay the sewer to this grade, but measurements for payment will be made only to the grade line. Master control lines and bench marks have been provided by the Engineer. The Contractor shall be responsible for the proper locations and grade of the sewers.

2.04 EXCAVATION

The Contractor shall perform all excavations of every description and of whatever substance encountered to the depth shown on the plans or specified for all sewers, manholes and other appurtenances. All trenches shall be properly dewatered before laying pipe, by the use of well points, pumping or other methods accepted by the Engineer.

The top portion of trenches may be excavated with sloping or vertical sides, except that the width of trench to a height of two (2) feet above the top of the pipe (embedment zone) shall not exceed two (2) feet greater than the diameter of the pipe.

Stone bedding beneath the pipe shall be required for all sewers and forcemains. Graded #57 stone shall be placed a minimum of six (6) inches deep and two (2) feet wider than the pipe at the barrel. Stone bedding shall be "compacted" using mechanical equipment to orient the stone and adjust trench bottom to grade. Compaction will be visually determined based on non-movement of material under compaction equipment.

Where the character of the soil is such that the Engineer determines it unsuitable to support the pipe bedding layer, an additional foot of excavation will be authorized and

the trench backfilled with an additional foot of stone to create a foundation for the pipe bedding material. If the trench bottom remains unsuitable, the Contractor shall provide additional foundation material or install a non-woven filter fabric, (Mirafi 140N or equivalent), beneath the stone layer, as directed by the Engineer. Excavation in excess of the depths and widths required for sewers, manholes and other structures shall be corrected by backfilling with stone to the proper grade.

The limit of excavation shall be such to allow for placing and removing forms, installing sheeting, shoring, bracing, etc. The Contractor shall pile excavated material in a manner that will not endanger the work and will avoid obstructing sidewalks, driveways, power poles, etc. Excavated areas shall be kept free of water during construction and proper site drainage shall be maintained.

See City of Savannah Standard Construction Detail S-16 for additional information on trench excavation and bedding.

2.05 BRACING AND SHEETING

The sides of all trenches shall be securely held by trench boxes, stay bracing, or by skeleton or solid sheeting and bracing, as required by the soil conditions encountered, to protect the adjoining property and for safety in accordance with OSHA requirements. Where shown on the drawings or where directed by the Engineer, the Contractor must install solid sheeting to protect adjacent property and utilities. The sheeting shall be steel or timber and the Contractor shall submit design data, including the section modules of the members and the arrangement for bracing at various depths, to the Engineer for review before installing the sheeting. Sheeting shall be removed in units when the backfilling has reached the elevation necessary to protect the pipe, adjoining property and utilities.

When sheeting or shoring above the elevation cannot be safely removed, it shall be left in place. Timber left in place shall be cut off at least two (2) feet below the surface.

2.06 LAYING PIPE

A. Gravity Sewer Installation:

Depth of Pipe – The Contractor shall perform excavation of whatever substances are encountered to obtain the invert elevations provided on the construction plans. Maximum depth shall be 20-feet. A four (4) foot minimum cover over the top of the

pipe is required. If the cover will be less than the minimum, ductile iron pipe shall be used.

Placement - All gravity sewer pipes shall be laid upgrade with spigots pointing downgrade. The pipe shall be laid in a trench prepared in accordance with Paragraph 2.04 "Excavation," so that after the sewer is complete, the interior surface shall conform on the bottom accurately to the grades and alignment fixed or given by the Engineer. Holes shall be provided to relieve bells from bedding strain, but not so large as to allow separation of the bell from the barrel by settlement after backfilling. All pipes shall be cleaned out and left clean. Every third joint shall be filled around immediately after being properly placed. The installer shall adhere to the recommendations of the manufacturer of the particular pipe joint used.

Grade - The sewer lines shall be straight and show a uniform grade between manholes. Any sags or bellies in the pipe sections shall not extend longer than ten (10) feet or hold water more than one-eighth of the pipe's inside diameter.

B. Forcemain Installation

Depth of Pipe – The Contractor shall perform excavation of whatever substances are encountered to obtain the invert elevations provided on the construction plans. Pipe 12-inches in diameter and smaller shall have 36-inches of cover from the proposed finished grade. Pipe larger than 12-inches in diameter shall have 48-inches of cover from the finished grade. If the depth of cover will be less than the minimum, ductile pipe shall be used. A maximum cover of 60-inches from finished grade shall be used unless approved by the City to avoid a conflict.

Placement - Forcemain shall be laid in a trench prepared in accordance with Paragraph 2.04 "Excavation", so that after the forcemain is complete, the interior surface shall conform on the bottom accurately to the grades and alignment fixed or given by the Engineer. Holes shall be provided to relieve bells from bedding strain, but not so large as to allow separation of the bell from the barrel by settlement after backfilling. All pipe shall be cleaned out and left clean. Every third joint shall be filled around immediately after being properly placed. The installer shall adhere to the recommendations of the manufacturer of the particular pipe joint used.

C. Field-Cut Ends

Whenever a pipe is cut to length in the field, the interior coating system (Protecto 401

ceramic epoxy) shall be repaired using the manufacturer's approved touch-up kits. Field repairs shall be made in accordance with the manufacturer's recommendations for surface preparation and compound application.

2.07 METAL DETECTOR TAPE

As a part of the installation of gravity or force main sewer, the Contractor shall place metallic detector tape, suitably coded, over the installed pipes at a depth not to exceed eighteen (18) inches below the finished surface.

2.08 TRACER WIRE

All force mains and sanitary sewer laterals below grade shall have tracer wire installed directly on the pipe in the 3 o'clock position. The wire shall be secured to the pipe with tape or other accepted methods at a spacing of no more than 36-inches apart. Where appurtenances connect to the force main, the specified spliced connector shall be used. The insulated wire must maintain electrical conductivity. In addition, tracer wire shall locate laterals by connecting cleanouts to gravity sewers. This tracer wire system shall be checked and tested by the Contractor, in the presence of the Engineer or project representative, prior to acceptance of the installation. All equipment, meters, detectors, etc. needed for testing shall be furnished by the Contractor.

2.09 SEPARATION BETWEEN WATER & SEWERS

Water mains and/or laterals shall not be laid below or closer than ten (10) feet horizontally to a sanitary or storm sewer without written instruction from the Engineer. Some deviation for unusual conditions may be allowed on a case by case basis if approved by the City for installation of the water main closer to a sewer, provided that the water main is laid in a separate trench, such that the bottom of the water main is at least eighteen (18) inches above the top of the sewer. In no case, shall the water and sewer lines be closer than five (5) feet horizontally edge to edge. Water mains crossing sewers should be laid to provide a minimum vertical distance of eighteen (18) inches between the invert of the water main and the top of the sewer line. For unusual crossing conditions where the water line is below the sewer, one full length of ductile iron water pipe shall be located so both joints will be as far from the sewer as possible and the . Refer to City of Savannah Standard Detail WS-1.

2.10 CONNECTIONS TO EXISTING SEWER MAINS

A. General

Lateral connections to existing sewer mains shall be either four (4) or six (6) inches in diameter. All laterals shall be attached to the main at either the 2:00 or 10:00 position; no laterals shall be attached to the main at the 12:00 position. Connections to existing sewer mains shall only be performed using a gasketed saddle or an Inserta Tee. The existing main shall be cut with a round cutter so that the saddle hub or tee boot and hub fits inside the opening; square holes cut with a pipe saw are not acceptable. The main must be protected from debris entering the pipe during the connection procedure. The area around the main shall be compacted to 100% standard proctor density. All connections to existing mains must be inspected by the City prior to backfilling.

B. Saddle Connections

Gasketed saddle shall match the existing sewer main pipe diameter. Stainless steel straps must be used to attach the saddle to the existing sewer main.

C. Inserta Tee Connections

Inserta Tee shall be designed for use with the existing sewer main pipe material and thickness. The Inserta Tee is installed by inserting the rubber boot inside the main. A properly lubricated PVC insert is then inserted inside the boot, and a stainless steel strap ties the boot to the insert. The insert then accepts PVC pipe of the appropriate size.

D. Depth of Pipe

Sanitary service laterals shall have a minimum depth of cover of three (3) feet under paved or other traffic areas or two (2) feet under non-traffic areas. If the minimum cover is not available, a ductile iron service lateral shall be required. Sanitary laterals shall have a minimum slope of 1% towards the collection system.

2.11 BACKFILLING

See City of Savannah Standard Construction Detail S-16 for additional backfilling information.

A. All trenches and excavation shall be backfilled immediately after the pipes are laid therein, unless other protection of the pipe line is directed. Backfill shall be spread in

successive layers of loose material. Each layer shall be spread uniformly and tamped until thoroughly compacted.

B. Haunching - Haunching for gravity sewer and forcemain pipe shall be #57 stone and installed from invert to springline by hand placement to ensure material is worked under the haunch of the pipe and so as to provide full bearing around the bottom of the pipe. Haunching shall be carried up evenly on both sides to prevent injurious side pressure.

C. Initial Backfill – Initial backfill is placed from the springline of the pipe to two (2) feet above the pipe. It is the final layer of backfill in the embedment zone. Initial backfill for gravity sewer lines shall be performed using Class II or better select backfill and for forcemains initial backfill shall be performed using Class III or better select backfill. Backfilling of the trench shall be carried on simultaneously on both sides of the pipe in such a manner that injurious side pressure does not occur. Trench backfill in the embedment zone shall be compacted in six (6) inch lifts.

D. Final Backfill – Final backfill is placed from above the embedment zone (two-feet above top of pipe) to final grade. Final backfill shall be performed using Class III or better common backfill material. Backfill may be selected from excavated material anywhere on the project site if the material is suitable. Backfill may be by hand or mechanical placement. Trench backfill above the embedment zone shall be compacted in twelve (12) inch lifts.

E. Compaction - Under traffic areas the top 12-inches of backfill material shall be compacted to a density of not less than 100% at optimum moisture. Below the 12-inch line and to and including the area around the pipe the density shall not be less than 95% at optimum moisture. In non-traffic areas, the backfill material shall be compacted to 95% density at optimum moisture. Compaction tests shall be conducted in accordance with ASTM D-1556 or D-2922 by an independent testing laboratory. The tests are to be taken at the direction of the Engineer at a frequency averaging not more than 100-foot intervals. Laboratory Tests shall conform to ASTM D-698.

F. Whenever the trenches have not been properly filled, or if settlement occurs, they shall be refilled, smoothed off and finally made to conform to the surface elevation of the ground. Backfilling shall be carefully performed and the original surface restored to the full satisfaction of the Engineer immediately after the installation. The finished surface shall be free of depressions and shall not allow ponding of runoff above utility lines.

G. Where thermoplastic (PVC) pipe is installed, the Contractor shall take precautions in accordance with ASTM D-2321, during the backfill operations so as not to create excessive side pressures, or vertical or horizontal deflection of the pipe so as not to impair flow capacity.

2.12 JACKING AND BORING

Steel casing of the diameter shown on the plans shall be jacked and bored in the locations indicated. Joints between sections of the steel casing shall be welded by a certified welder. Boring and jacking shall be in accordance with the provisions of Section 65 of the Georgia Department of Transportation Standard Specifications. After the carrier pipe has been installed, the ends of the casing shall be sealed with Class "C" concrete after observation by the Engineer.

Where the work involves a State highway, the Resident Engineer of the State Department of Transportation shall be notified by the Contractor three (3) working days before the crossing is started. Where the work involves a railroad, the work shall conform to the requirements of American Railway Engineering Association specifications and the Division Superintendent of the Railroad shall be notified three (3) working days prior to beginning the work. Before commencing work within the rights-of-way of the railroads or highways, the Contractor shall verify that the Owner has obtained the required permits.

2.13 MANHOLES

A. Manholes shall be constructed on compacted bedding material so structure is plumb and pipe inverts are at the proper elevation where shown on the drawings or where directed by the Engineer. Manholes shall be installed at the end of each line, at all changes in grade, size, or alignment, at all intersections, and at distances not greater than 400-feet. The channel in the bottom of the manholes shall be smooth and properly rounded and the invert channel shall be same size as installed sewer line. Special care must be exercised in laying the channel and adjacent pipes to grade. Invert piping shall not extend inside manhole any further than two (2) inches. Manhole sections with either honeycomb defects; exposed reinforcing; broken/fractured bell or spigot or cracked walls will be subject to rejection by the Engineers for use on the project. When mastic sealant is used, improperly applied primer will also be cause for rejection. Manholes in roads, streets, or highways shall be built to the pavement grade, the grade designated on the plans, or as directed by the Engineer. Tops of manholes outside of roads, streets, and highways shall be flush with the finished ground surface unless

otherwise shown on the plans. Manholes shall not be located in areas where ponding or the collection of surface water may occur.

B. No leaks in any manhole will be acceptable. All repairs made from inside the manhole shall be made with non-shrink grout.

C. When manhole repairs are made from the outside, liquid butyl primer and butyl rubber wrap shall be required per Section 1.04 A of this specification. When repairs require the removal and replacement of manhole barrel sections, liquid butyl primer, flexible plastic gasket, butyl rubber wrap, and grade adjustment rings or chimney seal gaskets shall be required per Sections 1.04 A and 1.04 B of this specification.

D. A one-tenth (0.1) foot minimum drop shall be required through all manholes where the horizontal alignment change is less than 45°. A two-tenths (0.2) foot minimum drop shall be required through all manholes where the horizontal alignment change is 45° to 90°. Horizontal alignment changes greater than 90° at a single manhole shall not be allowed.

E. Flow channels in the manhole base shall be formed of 3,000 psi concrete while the manhole is under construction. Flow channels shall be solid concrete or concrete with solid concrete filler block. No rubble shall be allowed. Non-shrink grout may be used for repair of existing manhole flow channels. The flow channel through manholes shall be made to conform in shape and slope to that of the sewers. Changes in size and grade of channels shall be made gradually and evenly. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit.

F. Installation of and surface preparation for expanded polypropylene grade adjustment rings shall be in accordance with the manufacturer's instructions. Repair any surface defects or irregularities of the mounting surface using a uniform bed of non-shrink grout. For concrete manholes the mounting surface shall be the top of the concrete cone section. For existing all-brick manholes, the mounting surface shall be the first full course of brick that is structurally sound, free from cracks or other voids that may allow infiltration into the collection system.

Dry-set grade adjustment rings and casting prior to sealing. Center casting over the opening of the cone and adjustment rings. The top adjusting ring upon which the casting is set shall be level from side to side unless a pitch is required to match the surface in paved areas. Manhole ring and cover shall be adjusted to within 1/4" to 1/2" of flat or sloping finished grade. Seal all joints from the mounting surface to the casting

using M-1 structural adhesive/sealant.

No other material shall be used in the construction of the chimney section beyond the materials specified. This includes shims of any material, bricks, stones, etc. If, after pavement placement, foreign material is discovered (i.e. – shims) in the manhole structure, the pavement surrounding the structure shall be removed and replaced and the manhole structure re-built as specified at the expense of the Contractor. Grade adjustment using expanded polypropylene rings shall range from a minimum of 2" to a maximum of 12".

Manhole chimneys are limited to a maximum height of 12". When adjusting the frame and cover elevation on existing pre-cast concrete manholes with brick chimneys in excess of the maximum 12" height in paved areas, the pre-cast barrel or riser cone sections will need to be replaced so that grade adjustment is obtained using expanded polypropylene rings between 2" and 12" in height.

2.14 PROTECTION OF EXISTING SANITARY SEWER SYSTEMS

During the construction of new Sanitary Sewer Systems, the existing sanitary sewer shall be protected at the point of connection with use of a pneumatic or mechanical plug. This isolation shall remain in place until the new system is fully accepted. Provisions must be in place to prevent sediment and excess water from entering the City's existing Sanitary Sewer System.

The isolation of the new system must be performed at the Contractor's expense. Any breach of this isolation shall be resolved by the Contractor to meet City expectations and standards. The Contractor may also be liable and responsible for remediation costs due to this breach.

2.15 CLEANING

Prior to mandrel tests, televising, and before acceptance of the gravity sewer systems, all sewer lines shall be cleaned to the satisfaction of the Engineer. Where any obstruction occurs, the Contractor will be required to clean the sewers by flushing and by means of rod and swabs or other instruments. Cleaning of new sewers is to be completed without impacting the existing sewer system; debris/foreign material from the new line (i.e. dirt, sand, and trash) shall not be discharged into the existing system.

2.16 TESTING AND INSPECTION

A. Leakage Testing: Mains and Laterals

All new public and private gravity sewers and laterals shall be pressure tested within 30 days following final backfill in accordance with the Time-Pressure Drop Method specified in ASTM F1417 - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air, latest revision. The procedure is summarized as follows:

1. Isolate the section of the sewer line to be tested using inflatable plugs or stoppers.

2. Cap all laterals and stubs using glued caps. All caps and plugs shall be securely braced to prevent blow-out.

3. One of the plugs or caps shall have an inlet tap or other provision for connecting a hose to a portable air control source.

4. Connect the air hose to the inlet tap and portable air control source. The air source equipment shall include necessary valves and pressure gages to pressurize an oil-free air source at a controlled rate into the test section.

5. Add air slowly to the test section until the pressure inside the pipe reaches four (4) psi greater than the average backpressure of any groundwater submerging the pipe. (NOTE: All test pressures are measured as gage pressure, which is any pressure greater than atmospheric pressure. Since water produces a pressure of 0.43 psi per foot of depth, air test pressures must be increased to offset the depth of groundwater over the sewer line. If the groundwater is two (2) feet or more above the top of the pipe at the upstream end, or if the required test pressure exceeds nine (9) psi, this test should not be used).

6. Disconnect the air supply and allow a minimum of two (2) minutes for pressure stabilization.

7. Measure the pressure drop over the following time period, depending on the diameter of the sewer pipe being tested (based on a maximum test section length of 400 feet between manholes):

8 inch:	6 minutes
10 inch:	8 minutes

12 inch:	12 minutes
15 inch:	18 minutes
18 inch:	26 minutes

8. Acceptable pressure drop over time period: Not more than 0.5 psi.

The testing shall be performed by the Contractor, and a representative of the City shall be present to observe the test. The Contractor shall be responsible for all costs associated with performing the leakage testing, locating leaks, repairing leaks, and conducting additional leakage testing as necessary until the system passes the pressure test. No gravity sewers or laterals will be accepted by the City without a passing pressure test.

B. Deflection of Mains

It is the responsibility of the Contractor to assure that backfill is sufficient to limit deflection for all PVC pipe, eight (8) inch diameter and larger, to no more than 5% of the internal diameter of the pipe which shall be tested by a mandrel permitting no greater than maximum 5% deflection. All pipe shall be tested no sooner than 30 days after installation. All pipes not passing the 5% deflection limitation test shall be repaired or removed and replaced.

The mandrel shall be pulled through the pipe (SDR-26) with the following diameter:

Nominal Pipe Size (Inches)	Average inside Diameter (Inches)	Mandrel Diameter (Inches)
8	7.754	7.37
10	9.692	9.20
12	11.538	10.96

C. Deflection of Laterals

It is the responsibility of the Contractor to assure that installation and backfill is sufficient to limit obstructions and deflections in the laterals. Laterals shall be tested by dropping a tennis ball in the upstream end of the pipe. The tennis ball must show up at the next downstream manhole. If not, the lateral must be repaired or removed and replaced. The tennis ball may be followed by water to help with its travel to the next downstream manhole.

D. Televising

After the completion of successful mandrel tests and cleaning, all newly constructed sewer lines must be televised by the City prior to acceptance. Accordingly, all sewer lines, eight (8) inches in diameter and larger, that are installed within accepted public right-of-ways and easements will be televised, including those lines on private property that are connected to the public lines. The Contractor will be charged a fee per linear foot by the City, and will be responsible for preparing the lines to insure that they are cleaned and free of debris prior to televising. The Contractor shall notify the Inspector on his progress prior to the televising request. Details and procedures of this program are included in the "Televising Procedures Manual" developed by the City's Water Quality Control Department who will be providing the television services. The Contractor will be responsible for becoming familiar with this manual, which is available on the City's Website.

E. Compaction

Laboratory tests of the soil shall be made in accordance with ASTM D-698. In-place density tests shall be made in accordance with ASTM D-1556 or D-2922. Results of the tests shall be furnished to the Engineer by the testing laboratory. The minimum number of tests required shall be:

1. Backfill over sewer in traffic areas: 1 per 100 linear feet or less for each four (4) feet of depth or portion thereof.

2. Backfill over sewer in non-traffic areas: 1 per 200 linear feet or less for each six (6) feet of depth or portion thereof.

2.17 CLOSING PIPE

When the work or pipe laying is suspended, either for the night or at other times, the end of the gravity sewer or force main pipe must be closed with a water tight cover. The Contractor will be held responsible for keeping the gravity sewer or force main free from obstruction. Plugs shall remain in pipe ends until all water is removed from the trench.

2.18 GRASSING

Grassing of areas disturbed during construction shall be in accordance with Section 02485 – "Grassing".

2.19 ACCEPTANCE OF PORTIONS OF THE WORK

The Owner reserves the right to accept and use any portion of the work whenever it is considered to the City's interest to do so. The Engineer shall have power to direct on which line the Contractor shall work and the order of the work.

2.20 RECORD DATA

As required under Section 1500, Paragraph 54, of the General Conditions, the Contractor is required during construction to keep accurate, legible records of the location of all new sewers, force mains, tees and laterals. This record data will include survey coordinates of all bends and fittings on force mains. These records will be made available to the Engineer before his final review for incorporation into the consulting Engineer's Record Drawings. Final payment to the Contractor will be withheld until all such information is received and accepted.

END OF SECTION 02554

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SECTION 02555

PROTECTIVE COATING FOR EXISTING AND NEW CONCRETE AND MASONRY SANITARY SEWER STRUCTURES

PART 1 – GENERAL

1.01 - GENERAL

A. This specification covers labor, materials, and equipment required for protecting and/or rehabilitating the interior of concrete sanitary sewer structures by application of a coating to protect the concrete structure from hydrogen sulfide and acid generated by microbiological sources present in the municipal wastewater environment. The protective coating shall also eliminate infiltration, repair voids, and enhance the structural integrity of the sanitary sewer structure. Procedures for surface preparation, cleaning, application and testing are described herein.

B. Cementitious material will not be allowed for the protective coating, however, it will be allowed for patching operations.

C. For new sanitary sewer manholes and valve pits: The protective coating shall be an acrylic polymer-base concrete coating and sealant. Procedures for surface preparation and application are described herein.

D. For force main discharge manholes (including the two (2) manholes downstream of the discharge manhole, for a total of three (3) manholes), drop manholes and lift station wetwells: The protective coating shall be a polymer based polyurethane or a high-build, solvent-free epoxy coating. For small lift stations and at the discretion of the City, the number of manholes requiring coating may be reduced.

   For lift station wetwells, the coating limits shall include from the bottom of fillet, wetwell walls, and roof. Coating system shall overlap 1" to 2" where hatches sit on the roof; but shall exclude the wetwell floor. For manholes, the coating limits shall include from the flow line in the trough of the invert up to the ring with a 1" to 2" overlay on the ring.

E. This specification also covers labor, materials, and equipment required for corrosion protection of the ductile iron discharge pipes and fittings within lift station wetwells.

1.02 - REFERENCES

A. ASTM D638 - Tensile Properties of Plastics.

B. ASTM D790 - Flexural Properties of Unreinforced/Reinforced Plastics.

C. ASTM D695 - Compressive Properties of Rigid Plastics.

D. ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gauges

E. ASTM D4541 - Pull-off Strength of Coatings Using a Portable Adhesion Tester.

F. ASTM D2584 - Volatile Matter Content.

G. ASTM D2240 - Durometer Hardness, Type D.

H. ASTM D543 - Resistance of Plastics to Chemical Reagents.

J. ASTM C109 - Compressive Strength Hydraulic Cement Mortars.

K. ACI 506.2-77 - Specifications for Materials, Proportioning, and Application of Shotcrete.

L. ASTM C478 - Bond Strength to Concrete: Concrete Failed.

M. ASTM C496 - Tensile Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.

N. ASTM C579 - Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.

O. ASTM - The published standards of the American Society for Testing and Materials, West Conshohocken, PA.

P. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.

Q. SSPC - The published standards of the Society of Protective Coatings, Pittsburgh, PA.

R. ASTM C396 - Compressive Strength of Cement Mortars.

S. ASTM C580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concrete.

T. ASTM D4541 - Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.

U. ASTM D4787 - Standard Practice for Continuity Verification of Liquid or Sheet Depth Applied to Concrete Substrates.

1.03 - SUBMITTALS

A. Product Data:

1. Technical data sheet on each product used, including ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.

2. Material Safety Data Sheets (MSDS) for each product used.

3. Project specific guidelines and recommendations.

4. Warranty Certificate in accordance with Part 1.08 of this Section.

5. For Lift Station Wetwells:

   a. Provide reference documentation to confirm that the proposed coating system has a proven record of performance when used in the intended application, including a list of at least five (5) successful installations that have been in service for a period of ten (10) years. The reference list shall include the name of the facility, the application date, a contact person, and a telephone number.

   b. Applicator Qualifications:

      1) Manufacturer certification that Applicator has been trained and approved in the handling, mixing and application of the products to be used.

      2) Certification that the equipment to be used for applying the products has been manufactured or approved by the concrete rehabilitation products manufacturer, protective coating manufacturer, and certified for proper use for this specific application.

      3) Written documentation of four (4) recent references of Applicator (involving wetwells with surface area of approximately 3,000 square feet) indicating successful application of a polyurethane or a high-build solvent-free epoxy coating.

      4) Applicator must provide written documentation of having installed a minimum of 40,000 square feet of protective coating similar to that specified within the last two (2) years.

5) Any project specific guidelines for the project.

6) Design details for any additional ancillary systems and equipment to be used in site and surfaced preparation, application and testing.

1.04 - QUALITY ASSURANCE

A. Applicator shall initiate and enforce quality control procedures consistent with applicable ASTM, NACE and SSPC standards and the protective coating manufacturer's recommendations.

B. Coating Manufacturer's authorized field representative shall be on site prior to the application of the coating system to verify that the substrate has been properly prepared, and during the application of the coating system to certify that the coating system has been properly applied. The authorized field representative will provide the Owner with an accurate and objective written report stating inspection observations on the preparation, application, and final inspection verifying adherence to coating manufacturer recommendations, industry standards, and the written specifications.

1.05 - DELIVERY, STORAGE, AND HANDLING

A. All materials are to be kept dry, protected from weather and stored under cover.

B. Protective coating materials are to be stored according to manufacturer's recommendations. Do not store near flame, heat or strong oxidants.

C. Repair and protective coating materials are to be handled according to their material safety data sheets.

1.06 - SITE CONDITIONS

A. Applicator shall conform with all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.

B. Method statements and design procedures are to be provided by the Contractor when confined space entry is required.

C. During coating operations of existing manholes and lift station wetwells, Contractor shall provide temporary flow bypassing of the structure if required by the City.

1.07 - ACCESS TO THE WORK SITE

A. Contractor shall provide proper facilities for such access and observation of the Work and also for any inspection or testing by others. If any Work is covered contrary to the request of the City of Savannah (COS) Representative, it must, if requested by the COS Representative, be uncovered for observation and replaced at the Contractor's expense.

B. Contractor shall provide access to site inspection.

1.08 - WARRANTY

A. Sanitary Sewer Manholes and Valve Pits:

All materials and workmanship shall be warranted to the owner for a period of five (5) years.

B. Force Main Discharge Manholes, Drop Manholes and Lift Station Wetwells:

1. Materials

The top coat manufacturer shall warrant the manufacturer's materials used on wastewater structures against failure of the system resulting in biogenic corrosion caused by exposure to sanitary sewer environment for the period of ten (10) years from the date of certified inspection and acceptance by the Owner. Within sixty (60) days of receiving written notice from the Owner, the manufacturer shall replace any defective product and the approved application contractor shall repair defects in materials and/or workmanship which may develop during the warranty period.

2. Application

The applicator shall warrant that all coating work performed shall be free of significant defects in materials and/or workmanship for a period of ten (10) years from the date of certified inspection and final acceptance by the Owner. Applicator shall remove, replace, or repair as he/she deems appropriate, such defective work.

3. Bypassing

In the event of liner failure, the City of Savannah Conveyance Department shall assist application contractor make the necessary repairs by bypassing the structures to be repaired. The City shall not bear any additional costs of coating repairs, such

as dewatering and cleaning structures, providing coating underlayment or top coat materials, or applying the coating system.

PART 2 - PRODUCTS

2.01 - REPAIR MATERIALS

A. Cementitious patching, repair, and structural restoration materials used shall be only those specified and pre-approved. Project specific submittals shall be provided including application, cure time and surface preparation procedures which permit optimum bond strength with protective coating.

B. Repair materials shall be used to fill voids, structurally reinforce and/or rebuild substrate surfaces, etc. as determined necessary by the engineer and protective coating applicator. Quick blending, rapid setting, high early strength, fiber reinforced, non-shrink repair mortar that can be trowelled or pneumatically spray applied must be compatible with the specified protective coating and shall be applied in accordance with the manufacturer's recommendations.

C. The following products are accepted and approved as compatible repair basecoat materials for protective topcoating for use within the specifications.

1. Infiltration Control

   All fast setting materials furnished shall be applied directly to active leaks under hydrostatic pressure from the exterior of the concrete in wetwell structures or control by dewatering methods. Materials shall consist of rapid setting cements and various accelerating agents. Material shall not contain chlorides, gypsum, or metallic particles.

   Should groundwater be encountered, Contractor shall be responsible for utilizing a dewatering system(s) to remove water from the excavations.

2. Repair, patching, and structural restoration

   All material furnished shall be designed to fill voids and to repair or reconstruct where no hydrostatic pressure exists. Material shall consist of rapid setting cements, NSG aggregates, and various accelerating agents. Material shall not contain chlorides, gypsum, or metallic particles.

All structural restoration materials shall be specifically designed for the rehabilitation of wastewater pump station wetwells and other related concrete structures. Materials shall contain poly fiber reinforcement, fused calcium aluminate, and chemical admixtures.

D. Structural Restoration Material Properties:

Product types	Fused Calcium Aluminate Cement OR Underlayment concrete approved by top coat system manufacturer
Cure Time	< 48 hours
Curing gases	Non-toxic
Compressive Strength	5,000 psi
Tensile Strength	500 psi
Flexural Strength	600 psi
Shrinkage	0% at 90% Relative Humidity

2.02 - SANITARY SEWER MANHOLES AND VALVE PITS

A. Interior and Exterior Coating Material

The interior and exterior of all manhole and valve pit structures shall be coated with three coats of a factory or field applied acrylic polymer-base concrete coating and sealant that is neither asphalt nor coal tar based. Acceptable coating is ConSeal CS-55, colors gray or black, as manufactured by Concrete Sealants, New Carlisle, Ohio or equal. The total dry film thickness shall be 3.5 mils. Coating shall be applied to the tongue and groove area of the manhole and valve pit sections as well.

B. The coating manufacturer and applicator shall inspect and certify all coatings prior to the coated pre-cast structures leaving the precast facility.

2.03 - FORCE MAIN DISCHARGE MANHOLES, DROP MANHOLES, AIR RELEASE VALVE MANHOLES & LIFT STATION WETWELLS

A. Structural Restoration & Coating Products:

1. Raven Lining Systems Products
2. Sauereisen Lining Products

3. Spectrashield Liner System Products
4. Or approved equal (2) weeks prior to bid date

B. Protective Coating Material:

Product type	Polyurethane or solid Epoxy
Color	Light
Compressive Strength	15,000 psi
Tensile Strength	1,500 psi
Hardness	Type D 60
Bond Strength – Concrete	> Tensile Strength of Concrete
Dry Film Thickness	125 mils

2.04 - APPLICATION EQUIPMENT

Structural restoration mortars and protective coatings shall be applied with manufacturer approved equipment.

PART 3 - EXECUTION

3.01 - ACCEPTABLE APPLICATORS

A. Repair mortar must be applied by manufacturer trained and approved applicators. The repair mortar shall be applied according to manufacturer's recommendations.

B. Protective coating must be applied by a Certified Applicator of the protective coating manufacturer and according to manufacturer specifications.

3.02 - EXAMINATION

A. Appropriate actions shall be taken to comply with local, state and federal regulatory and other applicable agencies with regard to environment, health and safety.

B. All bidders are required to verify that they have visited the jobsite, and are familiar with the conditions and the entire scope of work. Bidders shall field verify the attached plans and perform their own quantity measurements prior to bidding.

C. Contractor shall provide a minimum 24 hour notice to the COS Inspector / Representative for the following conditions:

1. After final surface preparation is completed but before structure rehabilitation;
2. After patching operations have cured, and
3. After each coating layer is applied.

D. Installation of the protective coating shall not commence until the concrete substrate has properly cured in accordance with these specifications.

E. Temperature of the surface to be coated should be maintained between 60° F and 100° F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the temperature is falling versus rising (i.e., late afternoon into evening vs. morning into afternoon).

3.03 - SURFACE PREPARATION

A. Applicator shall inspect all surfaces specified to receive a protective coating prior to surface preparation. The existing piping, valves, and appurtenances shall be protected during structural rehabilitation and protective coating application.

The pipes and connectors are to be top coated with 30-50 mils DFT nominal. The pipes and connectors are to be primed by the fabricator with epoxy primer (not cold-tar or asphaltic base) that is compatible with the protective coating. After installation, the pipes are to be pressure washed using at a minimum 5,000 PSI and 4 GPM washer and/or abrasive blast cleaned to an SSPC-SP7 'brush-off' specification as necessary for the window of overcoating of the primer.

Wetwell piping and connectors coated with the Zinc/Epoxy exterior coating system per City of Savannah Section 02554 - "Wastewater Collection System" Part 1.01 D, (Ductile Iron Pipe - Exposed Highly Corrosion Applications), shall not require top coating unless otherwise directed by the Engineer or Owner.

B. All contaminants including: oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed.

C. All concrete or mortar that is not sound or has been damaged by chemical exposure shall be removed to a sound concrete surface or replaced.

D. Old concrete must be firm and structurally sound as specified by the Engineer.

E. Surface preparation method(s) should be based upon the conditions of the substrate, service environment and the requirements of the protective coating to be applied.

F. Surfaces to receive protective coating shall be cleaned and abraded to produce a sound surface with adequate profile and porosity to provide a strong bond between the protective coating and the substrate. At a minimum, this will be achieved with a low pressure water cleaning equipment using a 0 degree rotating nozzle at a minimum 3,500 psi and 4 GPM. Other methods such as high pressure water jetting (refer to NACE Standard No. 6 /SSPC-SP 13), abrasive blasting, shot-blasting, grinding, scarifying and/or acid etching may also be used. In addition, detergent water cleaning and hot water blasting may be necessary to remove oils, grease or other hydrocarbon residues from the concrete. The method(s) used shall be performed in a manner that provides a uniform, sound clean, neutralized surface that is not excessively damaged.

3.04 - APPLICATION OF REPAIR MATERIALS

A. Areas where structural steel has been exposed or removed shall be repaired in accordance with the Project Engineer's recommendations.

B. Repair/Structural Restoration materials shall meet the specifications here and as described in part 2.01 A of these specifications. The materials shall be applied utilizing proper equipment on to specified surfaces. The structural restoration material shall match the original undamaged surface.

C. Infiltration shall be stopped by using a material which is compatible with the specified repair mortar, waterproof quick setting mortar-type that is suitable for topcoating with the specified protective coating. Contractor shall completely identify the types of grout, mortar, and sealant for repair of leak defects and provide case histories of successful use.

D. Infiltration areas that require crack injection shall be covered in this scope of work. Injection holes shall be drilled through the wetwell at 120° angles from each other at the same plane of elevation. Rows shall be separated no more than three vertical feet, and the holes shall be staggered with the holes in the rows above and below. Provide additional injection holes near observed defects and pipe seals. A minimum of 6 injection holes shall be provided per defect.

Grout shall be injected through holes under pressure with a suitable probe. Injection pressure shall not cause damage to the wetwell structure or surrounding surface

features. Grout shall be injected through the lowest holes first. Grouting from the ground surface will not be allowed. Provide additional injection holes if necessary to ensure grout travel, verified by field observation of grout at adjacent defects or holes. Patch injection holes using a waterproof quick setting mortar after cleaning with a drill.

E. The approved repair materials shall provide a smooth surface with an average profile equivalent to coarse sandpaper to optimally receive the protective coating. No bug-holes or honeycomb surfaces should remain after the final trowel procedure of the repair mortar.

F. The repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds should not be used unless approved for compatibility with the specified protective coating.

G. After required cleaning and repair is performed, all surfaces shall be inspected for remaining laitance prior to protective coating application. Any evidence of remaining contamination or laitance shall be removed by additional abrasive blast, shot-blast or other approved method. If repair materials are used, refer to these specifications for surface preparation. Areas to be coated must also be prepared in accordance with these specifications after receiving a repair mortar and prior to application of the protective coating.

3.05 - APPLICATION OF PROTECTIVE COATING

A. Application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment.

B. The equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.

C. The protective coating material must be applied by an applicator certified by the protective coating manufacturer.

D. Specified surfaces shall be coated by a moisture tolerant, solvent-free, protective coating properties as described in these specifications.

E. Application equipment approved by the coating manufacturer shall be used to apply each coat of the protective coating.

F. If necessary, subsequent topcoating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

3.06 - TESTING AND INSPECTION

A. During application a wet film thickness gage meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a uniform thickness during application.

B. After the protective coating has set hard to the touch it shall be inspected with high-voltage holiday detection equipment meeting ASTM D4787 – Standard Practice for Continuity Verification of Liquid or Sheet Depth Applied to Concrete Substrates. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All touch-up/repair procedures, for areas that do not meet the specified thickness, shall follow the protective coating manufacturer's recommendations.

   An SSPC Certified Coatings Inspector or NACE Certified Coatings Inspector must be present and monitor the holiday testing (and repairs, if necessary). The final inspection report is to include the holiday testing results.

C. A final visual inspection shall be made by the Inspector and manufacturer's representative. Any deficiencies in the finished coating shall be marked and repaired according to the procedures set forth herein by Applicator.

END OF SECTION 02555

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SECTION 02558

SEWAGE PUMPING STATION

PART 1 – PRODUCTS

1.01 GENERAL

Material and equipment used in the Sewage Pumping Station shall conform to this specification.

Pumps and associated equipment and controls shall conform to City of Savannah Section 11100 - "Submersible Wastewater Pumping Stations - Pump to Control Panel."

Pump station wiring and conduits assemblies shall conform to City of Savannah Section 16000 - "Wires and Conduits."

Pumping station SCADA and instrumentation shall conform to City of Savannah Section 16400 - "SCADA Communication and Misc. Instruments."

Pumping station motor starters and drives shall conform to City of Savannah Section 16482 - "Pump Motor Starters and Drives."

Sewage pumping station stand-by power systems shall conform to City of Savannah Section 16620 - "Sanitary Sewer Pump Station Emergency Stand-By Power System."

1.02 PUMPING STATION

A. Concrete Structures & Piping (General) – Wetwells and valve pits shall be precast reinforced concrete sections conforming to ASTM C-478 or cast-in-place Portland cement conforming to ASTM C150, type II 4,000 psi and absorption shall not exceed 6%. The footing shall be concrete placed on a dry, compacted subgrade. The footing shall be designed to prevent flotation of the empty structures. Wetwell and valve pit penetrations shall require stainless steel wall sleeves and link-seals with stainless steel hardware in accordance with City of Savannah Standard Construction Detail S-12. Precast concrete wetwells and valve pits shall be manufactured at plants certified by the National Precast Concrete Association.

A liquid butyl primer shall be applied by the precast manufacturer to all three faces of the tongue and groove joint, both bell and spigot, and 8" of wetwell exterior above and

below joint. Primer shall be ConSeal CS-50 or approved equal. Flexible plastic gasket shall be placed on each of the three joint faces of wetwell and valve pit sections. Gasket shall be RAM-NEK or approved equal. The exterior of all joints shall be wrapped with a butyl rubber wrap ConSeal CS-212, or approved equal. Wrap shall have a minimum thickness of 65 mils and minimum width of 12". All joint sealant materials shall be applied to clean, dry surfaces and as recommended by the manufacturer. All joint sealant materials shall attach firmly to the concrete surfaces without the use of additional adhesives, tape, or other fastening devices.

For the protective coating on wetwells, manholes, and dry pits, see City of Savannah Section 02555 - "Protective Coating for Existing and New Concrete and Masonry Sanitary Sewer Structures." All piping and fittings within the wetwell from the pump base through the valve pit are exposed to highly corrosive conditions and shall be ductile iron pipe conforming to City of Savannah Section 02554 - "Wastewater Collection System," Part 1.01 D. Pipe connections within the wetwell and dry pit shall be flanged ductile iron conforming to Part 1.02 B.2a of Section 02554.

B. Wetwells - Wetwells shall be constructed to the dimensions shown on the drawings. Depth of wetwells shall not exceed 28 feet below existing grade.

The top slab of the wetwell shall have an access hatch with minimum 48" x 30" (inch) clear opening, with a live load capacity of 300 pounds per square foot. A larger access hatch may be required if necessary to allow pump installation and removal. The access hatch shall include a Flygt Safety grate. The material shall be Aluminum Alloy 6063-T5 and T6 1/4" (inch) tread plate, flush type lock with inside spoon handle. The frame shall be complete with hinged and hasp-equipped cover, upper guide holders, chain holders and stainless steel cable holder. Frame shall be securely mounted directly above the pumps. The door shall be torsion bar loaded for ease of lifting and shall have safety locking handle in open position. Fastening hardware used inside the wetwell shall be stainless steel.

The Contractor shall furnish and install guide rails for each pump, to permit the raising and lowering of the pump. Guide bars shall be 316 stainless steel and of adequate length and strength to extend from the lower guide holders on the pump discharge connection to the upper guide holder mounted on the access frame. Guide rails shall be installed plumb with stainless steel intermediate supports as required by the Engineer.

All conduit entering pump station should be sealed air tight at the wet well and at the control panel. Once above grade, these conduits shall also have an air gap immediately below the control panel. Conduit shall be sealed air tight on either side of the air gap.

C. Lift Station Valve Pit – The valve pit shall be constructed to the dimensions shown on the drawings.

The top slab of the valve pit shall have an access hatch with a minimum 36" x 48" (inch) clear opening, with a live load capacity of 300 pounds per square foot. A larger access hatch may be required if necessary to remove / install plug and check valve assemblies by vertical lifting. The material shall be Aluminum Alloy 6063-T5 and T6, 1/4" (inch) tread plate with a neoprene gasket to make hatch water tight. The frame shall be securely mounted directly above the plug and check valve assemblies. The hatch cover shall be equipped with a cast aluminum flush handle and aluminum hasp for securing with Owner's lock. Access hatch shall include Type 316 stainless steel heavy duty hinges, tamper proof attaching hardware, and automatic hold open arm with aluminum latch. Fastening hardware used inside the dry pit shall be stainless steel.

Drains from the valve pit shall discharge back to the wetwell and include a duckbill check valve at the discharge. Valve pits shall include vents with stainless steel screening.

D. Plug Valves - Shall be of the non-lubricated, eccentric type conforming to AWWA C517 with resilient faced plugs, and Class 125 ANSI flanges. Valves to 20" size shall be round port or have a port area equivalent to 100% of full pipe area and all valves 24" and larger shall be 100% port area. Valve body and bonnet shall be made from ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 Class B cast iron, internally and externally coated with 6-mil epoxy. Valve seats shall have a welded-in overlay of high nickel content on all surfaces contacting the plug face. Valves shall have permanently lubricated, stainless steel bearings in the upper and lower plug stem journals. All valves shall have bolted bonnets and adjustable compression packing or self-adjusting U-cup packing that can be replaced without removing the bonnet. All exposed nuts, bolts, springs, and washers shall be zinc plated. O-ring seals are not acceptable.

All valves larger than eight (8) inches shall be equipped with a gear actuator with handwheel. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant, with seals provided on all shafts to prevent entry of dirt and water into the actuator. The actuator shaft and quadrant shall be supported on permanently lubricated bronze bearings. Actuators shall clearly indicate valve position

and an adjustable stop shall be provided to set closing torque. All exposed nuts, bolts, and washers shall be zinc plated.

All eccentric plug valves eight (8) inches or less shall be crossbar operated. A mechanical brake shall be provided and capable of locking the valve in any intermediate position between full open and full closed.

E. Check Valves - Shall be of cushioned swing type and shall meet the materials requirements of AWWA specification C508. The valve shall be cast iron body, bronze mounted, single gate for non-shock working pressure of 175 psi. The valve shall be so constructed that by simply unbolting and lifting off the cover, the internal working parts may easily be removed and replaced without removing the valve from the line. The valve shall be furnished with outside lever and spring with non-corrosive adjustable air cushioned shock chamber. Check valves shall be suitable for mounting in horizontal lines or vertical lines when water flow is up. Check valves shall have a stainless steel hinge pin. Hinge pin shall operate in bronze support bearings. Check valves should close without any hammering action.

F. Pressure Gauge – Pressure gauge shall be 0 to 100 psi unless otherwise indicated on the drawings. Gauge accuracy shall be within 0.5% of the total scale range. Provide diaphragm isolators on all gauges so that their materials of construction are resistant to wastewater. Pressure shall be transmitted to the gauge by a locked in and sealed fluid such as ethylene glycol or silicone oil. Elastomer shall be Butyl or Neoprene. The pressure gauge shall be equivalent to Series 40 as manufactured by Red Valve Co. The pressure gauge will be installed in the valve pit upstream of the plug valves. The installation shall include a 3/4" (inch) tap with a stainless steel nipple and ball valve for isolation. The ball valve shall be stainless steel.

G. Pump Station Hose Bib – Shall be 3/4" size including meter, backflow prevention device and hose bib, as shown on City of Savannah Standard Construction Detail, W-23. Adhere to the minimum separation requirements for water and sewer lines as shown on the City of Savannah Standard Construction Detail WS-1.

H. Flow meter – All pump stations that are controlled by variable frequency drives shall have a flow meter in accordance with City of Savannah Section 16400 - "SCADA System Communication and Misc. Instruments."

I. Pump Bypass Line – All lift stations shall include a pump bypass line, suitable for use with temporary pumps and for force main pigging. Bypass shall include female cam-lock

fitting and plug valve. For larger stations, additional requirements may apply and designer shall coordinate with City.

J. Yard Cover – The entire lift station site within the fenced area shall be covered with a layer of six-inch thick crusher run aggregate over a 40-mil visqueen under layer.

K. Lighting – Lift station sites shall include a minimum of one pole-mounted, overhead street lamp. Lamp shall be positioned so that it will illuminate the control panel and wet well area.

L. Site Fencing and Gate – Sewage pumping station site shall be completely enclosed by a gated security fence. Fencing shall be chain link galvanized steel (black powder coated with green vinyl coated wire) and barbed wire. Fencing shall be a minimum of eight feet tall (height includes barbed wire). A cantilever slide gate shall also be provided with a minimum clear opening of twelve (12) feet. If cantilevered gate is not possible due to space considerations or local requirements, gate shall open inward to the site without obstruction. These are minimum standards; local requirements may require different fencing material and heights.

M. Sign - One sign shall be attached to the fence at the pump station with the appropriate lift station number. The sign shall be 30" x 24" (inches) and 1-1/8" (inches) thick made of white enameled aluminum with the following inscription:

NO TRESPASSING	**[Red Letters]**
CITY OF SAVANNAH	[Black Letters]
CONVEYANCE & DISTRIBUTION DEPARTMENT	[Black Letters]
LIFT STATION # _____	[Black Letters & Numbers]
351-3434	[Black Numbers]

N. Access Road - Access Road to the station shall be as shown on the drawing. Stabilization shall be accomplished by constructing a base using eight (8) inches of crusher run aggregate.

1.03 PRODUCT REVIEW

The Contractor shall provide the Engineer with a complete description of all products before ordering. The Engineer will review all products before they are ordered. Contractor shall obtain approval from the Engineer.

PART 2 - EXECUTION

2.01 CONSTRUCTION OBSERVATION

The Engineer will have the right to require that any portion of the work be done in his presence and if the work is covered up after such instruction, it shall be exposed by the Contractor for observation. However, if the Contractor notifies the Engineer that such work is scheduled and the Engineer fails to appear within 48 hours, the Contractor may proceed without him. All work done and materials furnished shall be subject to review by the Engineer or Project Representative. Improper work shall be reconstructed. All materials which do not conform to the requirements of the specifications shall be removed from the work upon notice being received from the Engineer for the rejection of such materials. The Engineer shall have the right to mark rejected materials so as to distinguish them as such.

The Contractor shall give the Project Engineer or Project Representative a minimum of 48 hours notice for all required observations or tests.

It will also be required of the Contractor to keep accurate, legible records of the location of all pump stations, force mains, and appurtenances. These records will be prepared in accordance with the "Record Data" paragraph in the Special Conditions. Final payment to the Contractor will be withheld until all such information is received and accepted.

2.02 LOCATION AND GRADE

The grade and the position of all pumping stations, force mains, and other structures are shown on the drawings. The grade line as given on the profile or mentioned in these specifications means the invert or bottom of the pumping station and the price for installation shall include the excavation for the depth below this line necessary to install the pumping station to this grade, but measurements for payment will be made only to the grade line. Master control lines and bench marks shall be provided by the Engineer. The contractor shall be responsible for the proper locations and grade of the pumping stations and force mains.

2.03 EXCAVATION

The Contractor shall perform all excavations of every description and of whatever substance encountered to the depth shown on the plans or specified for all pumping stations, force mains and other appurtenances. All excavations shall be properly

dewatered before installations are made, by the use of well points, pumping or other methods accepted by the Engineer. The top portion of trenches may be excavated with sloping or vertical sides, except that the width of trench to a height of 2-feet above the top of the pipe shall not exceed 2-feet greater than the diameter of pipe.

Where the character of the soil is such that the Engineer determines it unsuitable for bedding, an additional foot of excavation will be authorized and the excavation backfilled with stone backfill. The limit of excavation shall be such to allow for placing and removing forms, installing sheeting, shoring, bracing, etc. The Contractor shall pile excavated material in a manner that will not endanger the work and will avoid obstructing sidewalks, driveways, power poles, etc. Drainage shall be kept clear.

2.04 BRACING AND SHEETING

The sides of all trenches and excavations shall be securely held by stay bracing, or by skeleton or solid sheeting and bracing, as required by the soil conditions encountered, to protect the adjoining property and for safety. Where shown on the drawings or where directed by the Engineer, the Contractor must install solid sheeting to protect adjacent property and utilities. The sheeting shall be steel or timber and the Contractor shall submit design data, including the section modulus of the members and the arrangement for bracing at various depths, to the Engineer for review before installing the sheeting. It shall penetrate at least three (3) feet below the pumping station or force main invert. Sheeting shall be removed in units when the backfilling has reached the elevation necessary to protect the pumping station, force main, adjoining property and utilities.

When sheeting or shoring cannot be safely removed, it shall be left in place. Timber left in place shall be cut off at least two (2) feet below the surface. No separate payment shall be made for bracing and sheeting except where shown on the drawings or authorized by the Engineer.

2.05 SEWAGE PUMPING STATION

The underground pumping station and valve pit shall be built in holes kept dry by pumping or well points. The base shall be placed on compacted bedding material so structure is plumb and pipe inverts are at proper elevations. The barrel and top sections shall be placed in the appropriate height combinations. All lifting holes inside and out shall be plugged with non-shrink grout. The sealing of joints between precast sections shall be completed as described in this Section – 02558, Part 1.02 A. Backfilling shall be

made with selected sandy material compacted by mechanical tamping to 98% density when tested by AASHO Method T-191 or T-238. Depth of wet well shall not exceed twenty-eight (28) feet below proposed grade.

The wetwell shall be constructed of pre-cast or reinforced concrete to the dimensions shown on the drawings. The foundations shall be placed on well compacted, dewatered soil. The top shall be reinforced concrete of the dimensions shown on the drawings. Concrete shall conform to ASTM Standard C-94 for ready-mixed concrete. Construction shall be in accordance with applicable portion of "Building Code Requirements for Reinforced Concrete" (A.C.I. - 318). Class A concrete shall have a 4,000 psi compressive strength at 28 days.

Pump station sections with honeycomb defects, exposed reinforcing, broken / fractured bells or spigots, or cracked walls will be subject to rejection by the Engineer for the use on the project.

The pumping station site shall be graded to drain to conform to the drawings. The fence, access road and grassing shall be constructed in accordance to the approved design after the site has been graded.

The Contractor shall connect to the water main with a saddle or tee and lay one (1) inch diameter (minimum) pipe to the 3/4" hose bib at the station. The hose bib riser pipe shall be schedule 40 galvanized steel. Pipe fittings shall be galvanized iron. Hose bib assembly shall extend two (2) feet above grade, and be set in a 12" x 12" x 4" concrete collar at the ground level. Backflow preventers are mandatory on all water lines inside a lift station according to the City of Savannah, Cross Connection Control Policy. Connection shall be disinfected and tested in accordance with AWWA C-601. Water shall not be used until favorable written test results have been furnished to the Engineer.

2.06 BACKFILLING

Backfilling and related structures Pump Stations shall be backfilled in accordance with City of Savannah Section 02200 - "Earth Work."

Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying material uniformly around structure to approximately same elevation in each lift.

Do not allow heavy machinery within five (5) feet of structure during backfilling and compacting.

2.07 STONE BACKFILL

Where, in the opinion of the Engineer, the subgrade of the pump station or related structures is unsuitable material, the Contractor shall remove the unsuitable material to 12-inches below the subgrade and furnish and place stone backfill to stabilize the subgrade. Attention is invited to the fact that the presence of water does not necessarily mean that stone backfill is required. If well points or other types of dewatering will remove the water, the Contractor shall be required to completely dewater the trench in lieu of stone backfill. Stone backfill will be limited to areas where well pointing and other conventional methods of dewatering will not produce a dry bottom. Stone shall be placed 12-inches deep and 2-feet wider than the structure.

2.08 RECORD DATA

It will be required of the Contractor to keep accurate, legible records of the location of all pumping station features in both the horizontal and vertical planes. These features include, but are not limited to: receiving manhole, influent piping, wet well, valve pit, effluent force main, hose bib, and backflow preventer. These records will be made available to the Engineer before his final review for incorporation into the Engineer's Record Drawings. Final payment to the Contractor will be withheld until all such information is received and accepted.

2.09 COMPACTION TESTING

Soil and compaction tests shall be made by a testing laboratory accepted by the Engineer and shall be made at the City's direction and expense. Failed tests shall be rescheduled at the City's direction and retesting shall be paid for by the Contractor. Laboratory tests of the soil shall be made in accordance with ASTM D-698. In-place density tests shall be made in accordance with ASTM D-1556 or D-2922. Results of the tests shall be furnished to the Engineer.

END OF SECTION 02558

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SECTION 02559

HORIZONTAL DIRECTIONAL DRILLING (HDD)

PART 1 – GENERAL

1.1 WORK INCLUDED:

A. The work under this Section is horizontal directional drilling which shall include all work, materials, labor and related necessary for the installation of a Fusible Polyvinylchloride (FPVC) pressure pipe, as shown on the Drawings and as specified herein. Services provided by the Contractor shall be performed in accordance with the current industry practice and these Specifications. The Contractor shall accomplish, but is not limited to, the following tasks:

1. Site preparation necessary for construction.
2. Transportation of all equipment, labor, and material to and from the project location.
3. Provide and assemble FPVC carrier pipe.
4. Erection and dismantling of drilling equipment at the project location.
5. Drilling of a small diameter pilot hole along the alignment.
6. Reaming the pilot hole to a diameter suitable for installation of the steel casing pipe.
7. Pulling the assembled steel casing and FPVC carrier pipe through the reamed hole along with a detector wire.
8. Hydrostatic testing of the FPVC pipe.
9. Disinfection and bacteriological testing of FPVC pipe before and after installation.
10. Removal of all equipment and materials upon completion of construction.
11. Cleanup and final restoration of all work areas.

B. Related Work:

1. Work associated with providing and installing FPVC pipe is specific in Section 02610 of these Specifications.

1.2 INSPECTION:

The Contractor will provide and maintain instrumentation, which will accurately locate the pilot hole and measure drilling fluid flow discharge rate and pressure at all times. The Engineer will have access to these instruments and readings.

1.3 SUBMITTALS:

Shop drawings shall be submitted, as required by the contract documents, for the following:

1. **Installation Plan: At least 30 days prior to mobilizing equipment, Contractor shall submit detailed installation plan to the Engineer. The plan shall include a detailed plan and profile of the proposed bores and shall be plotted at a scale no smaller than 1–inch equals 20 feet vertical and horizontal.**

2. Details describing the proposed method of directional drilling. This shall include, but is not limited to, arrangement of equipment, location and size of drilling and receiving pits, methods of dewatering, method of removing spoils material, size and capacity of equipment, method of installing pipe, method of installing detection wire, pipe and seals, support segments, method of monitoring and controlling line and grade and provisions for protecting existing structures. Directional drilling work shall not proceed until shop drawings have been reviewed and accepted by the Engineer. If, in the opinion of the Engineer, modifications to the methods are necessary during construction, the Engineer may direct the Contractor to discontinue any directional drilling activities until proper drawings are submitted and accepted delineating such modifications.

3. Bentonite/drilling mud or other drilling fluid: product information, material specifications, handling procedures, material safety data sheet, special precautions required, and method of mixing and application. Also, submit information on the pit lining material.

4. Methods and material for joining ends of directionally drilled pipe segments.

5. A Georgia Registered Professional Engineer other than Thomas & Hutton Engineering Co. shall design the final steel casing (if applicable) and FPVC pipe wall thickness and shall submit the stamped design calculations to the Owner (assume the area between the steel casing and the FPVC pipe contains water).

6. Manufacturer's certificate documenting the pipe and fittings has been tested and meet the specifications.

7. Equipment: Contractor will submit specifications on directional drilling equipment used to ensure the equipment will be adequate to complete the project. Equipment shall include, but not be limited to, drilling rig, mud system, mud motors (if applicable), down–hole tools, guidance system, and rig safety systems. Calibration records for guidance equipment shall be included. Specifications for any drilling fluid additives the Contractor intends to use or might use will be submitted.

8. Material: Specifications on materials used shall be submitted to Engineer. Material shall include the pipe, fitting, and any other item to be an installed component of the project.

1.4 QUALITY ASSURANCE:

The requirements set forth in this document specify a wide range of procedural precautions necessary to ensure that the very basic, essential aspects of a proper directional bore installation are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this specification or within any associated permit (i.e.: DEP, DOT, Etc.). Adherence to the specifications contained herein, or the Representative's approval on any aspect of any directional bore operation covered by this specification, shall in no way relieve the Contractor of their ultimate responsibility for the satisfactory completion of the work authorized under the Contract. The HDD contractor shall be responsible for the repair of all damage to private and/or public property (at no expense to the Owner. Repair work shall meet all local and state rules and requirements.

1.5 QUALIFICATIONS:

A. The work shall be accomplished by trained workers with a minimum of three years of directional drill experience. The Contractor's on–site superintendent shall have a minimum of five years' experience. The Contractor shall have installed directionally drilled pipe at least as large as 12 inches in diameter and have performed crossings at least 2,000 feet in length.

B. A Georgia Registered Professional Engineer, other than Thomas & Hutton Engineering Co., shall design the final steel casing size and thickness and FPVC pipe wall thickness and shall submit the stamped design calculations to the Owner (assuming the area between the steel casing (if applicable) and the FPVC pipe contains water).

C. Experience: Each bidder shall submit a list of experience with their bid for the directional drilling Contractor (or Subcontractor) presenting similar experience on at least five projects involving road crossings of 12 inches or greater in the Contractor's qualification form.

D. Material and equipment shall be the standard product of a manufacturer who has manufactured them for a minimum of two years and who provides published data on the quality and performance of the product.

A subcontractor for any part of the work must have experience on similar work and, if required, furnish the Engineer with a list of projects and Owners or Engineers who are familiar with its competence.

All testing of the piping shall be made by the Contractor with equipment qualified by the Owner, Engineer, or utility company and in the presence of the Engineer, Owner and utility company. The Engineer or Project Representative reserves the right to accept or reject testing equipment.

1.6 REFERENCES:

1. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those other standards are included as references under this section as if referenced directly. In the event of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

2. Unless otherwise specified, references to documents shall mean the documents in effect at the time of design, bid, or construction, whichever is earliest. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued.

3. Where documents dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued, or replaced.

REFERENCE	TITLE
ANSI/AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4 inch through 63 inch, for Water Distribution American Society for Testing and Materials (ASTM) Standards.
ASTM D638	Standard Test Method for Tensile Properties of Plastics.
ASTM D2122	Standard Method of Determining Dimensions of Thermoplastic 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 for Thermoplastic Pipe Materials.
ASTM D3035	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR–PR) Based on Controlled Outside Diameter.
ASTM E3261	Standard Specification for Butt Heat Fusion Polyethylene Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
ASTM D3350	Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
ASTM F412	Standard Terminology Relating to Plastic Piping Systems.
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR–PR) Based on Outside Diameter.
ASTM F2620	Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

1.7 PRODUCT DELIVERY, STORAGE & HANDLING:

Material shall be unloaded in a manner avoiding damage and shall be stored where it will be protected and will not be hazardous to traffic. The Contractor shall repair any damage caused by the storage. Material shall be examined before installation and neither damaged nor deteriorated material shall be used in the work. Owner and Engineer have the right to reject defective or damaged material. If stored on private property, Contractor shall obtain permission from the property owner and shall repair all damage caused by the storage.

1.8 SEQUENCING AND SCHEDULING:

The Contractor shall arrange work so sections of mains between valves are tested, sterilized, pavement replaced, and the section placed in service as soon as reasonable after it is placed. Owner reserves the right to dictate the sequence of construction.

1.9 ALTERNATIVES:

The intention of these specifications is to define the acceptable methods and materials for installing FPVC Pipe by horizontal directional drilling and to produce the best system for Owner. If Contractor suggests alternative material, equipment or procedures will improve results at no additional cost, the Engineer and Owner will examine suggestion, and if it is accepted, it may be used. The basis upon which acceptance of an alternative will be given is its value to Owner, and not for convenience of Contractor.

1.10 CALCULATIONS:

The Contractor shall submit final design calculations for [Owner's] [and] [Engineer's] review and approval within 90 days of receiving notice to proceed. Final design calculations shall support the Contractor's specific proposed means, methods, and products. The Contractor's final design calculations shall be prepared and sealed by a Licensed Professional Engineer registered to practice in the State of [Georgia] [South Carolina] [North Carolina] [Tennessee] and retained by the Contractor. Horizontal directional drilling shall not commence until the Contractor has received written approval of all design calculation submittals from [Owner's] [and] [Engineer's.]

At a minimum, design calculations shall demonstrate that the proposed pipe, equipment, and means and methods comply with the requirements of this Section and have been designed based on the design borepath, and installation means and methods, for anticipated installation and handling, hydrostatic, earth, and live loads, installation temperature and site conditions. Design calculations shall address the considerations and guidelines presented in ASTM F1962.

The Contractor shall supply copies of all other calculations required to support the required submittals for horizontal directional drilling. At a minimum, the following calculations should be included:

A. Maximum allowable pipe loading limits

B. Pullback load calculation based upon proposed drill path plan and profile.

C. Bouyancy effect calculations.

D. Effects of ballasting plan on pipe pullback forces.

E. Hydrofracture analysis. This should include a maximum annular pressure curve and the respective formation pressure versus depth based on the proposed drill plan and profile.

F. Confirmation that design parameters do not exceed predicted installation stresses including factors such as tensile load, buckling and deformation.

1.11 GUARANTEE:

Contractor shall guarantee the quality of materials, equipment, and workmanship for a period of 18 months after final project acceptance. Defects discovered during period shall be repaired by the Contractor at no cost to the Owner. Contractor shall provide an 18–month guarantee.

1.12 WARRANTY:

The contractor shall supply to Owner a two (2) year unconditional warranty. The warranty shall include materials and installation and shall constitute complete replacement and delivery to the site of materials and installation of same to replace defective materials or defective workmanship with new materials/workmanship conforming to the specifications.

The pipe manufacturer shall provide a warranty to the contractor that the pipe conforms to these specifications and that the pipe shall be free from defects in materials and workmanship for a period of two (2) years from the date of substantial completion of the installation. The manufacturer's warranty shall be in a form acceptable to and for the benefit of Owner and shall be submitted by the contractor as a condition of final payment. The manufacturer's warranty to the contractor shall in no way relieve the contractor from its unconditional warranty to Owner.

The contractor shall warrant to Owner that the methods used on the contract, where covered by patents or license agreements, are furnished in accordance with such agreements and that the prices included herein cover all applicable royalties and fees in accordance with such license agreements. The contractor shall defend, indemnify, and hold Owner and Engineer harmless from and against any and all costs, loss, damage or expense arising out of, or in any way connected with, any claim of infringement of patent, trademark, or violation of license agreement.

1.13 EXISTING UTILITIES:

All known utility facilities are shown schematically on plans, and are not necessarily accurate in location as to plan or elevation. Utilities such as service lines or unknown facilities not shown on plans will not relieve the Contractor of responsibility under this requirement. "Existing Utilities Facilities" means any utility existing on the project in its original, relocated, or newly installed position. Contractor will be held responsible for the cost of repairs to damaged underground facilities – even when such facilities are not shown on the plans. The Contractor shall contact all utility companies prior to beginning work and request an accurate field location of their respective utility lines. Contractor shall also be responsible for exposing ("potholing") existing utilities as required by utility owner to verify horizontal and vertical position of utility prior to start of bore operations. There will be no separate measurement or payment for any and all labor, equipment, or materials, or incidentals required to locate and expose existing utilities. These costs shall be considered a subsidiary obligation of the contract.

1.14 ENVIRONMENTAL PROTECTION:

Contractor shall place silt fence between all drilling operations and any drainage, wetland, waterway or other area designated for such protection by contract documents, state, federal and local regulations. Contractor shall place hay bales, or approved protection, to limit intrusion upon project area. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. Contractor shall adhere to all applicable environmental regulations including environmental condition stated in local, state and federal permits. Fuel may not be stored in bulk containers (greater than 25 gallons) within 200' of any water–body or wetland.

1.15 CONNECT NEW MAIN TO EXISTING SYSTEM:

Contractor shall furnish necessary pipe and perform all excavation, dewatering, shoring, backfilling, etc., necessary to make the connection of a new main to existing system to be or already installed by others. Contractor shall contact the utility a minimum of 72 hours in advance of construction. Contractor shall be responsible for coordinating construction with the utility.

1.16 DAMAGE TO EXISTING WATER SYSTEM:

Damage to any part of existing water system by Contractor or Subcontractors, which is repaired by Utility Owner's forces, or an acceptable Contractor shall be charged to the Contractor on basis of time and material, plus an overhead and administration charge using Commission's multiplier, or plus 30% for overhead and administration for an acceptable Contractor.

1.17 CONSTRUCTION RECORDS:

A. Daily Reports: The Contractor shall maintain daily activity reports throughout all horizontal directional drilling operations, including pipe installation. A sample daily report shall be submitted to Engineer for approval prior to the commencement of drilling operations. Daily reports shall be submitted within 24 hours of completion, and shall include, for each drill rod added or withdrawn, or every 30 feet during drilling, pre–reaming, and pullback:

1. Downhole tools and equipment in use.
2. Description of ground conditions encountered.
3. Description of drilling fluid.
4. Drilling fluid pumping rate.
5. Maximum and minimum downhole fluid pressures.
6. Drilling head location – at least every 10 feet along the bore path.
7. Drill stem torque.
8. Details and perceived reasons for delays greater than one hour other than normal breaks and shift changes.
9. Details of any unusual conditions or events.

B. Production and As–built Drawings: The Contractor shall maintain at the construction site a complete set of field drawings for recording the as–built conditions. The Contractor shall plot as–built conditions on the field drawings, including the location in plan and elevation of the drill string, reaming head, and installed pipe, at the completion of each production shift. The Contractor shall compile and submit as–built data in accordance with Engineer's standards. As–builts shall include all bores successful and failed.

C. Testing and Quality Control and Assurance Documentation: The Contractor shall maintain records for all testing and quality control and assurance procedures. The following records shall be provided to Engineer on the day that information is acquired by the Contractor:

1. Manufacturer's field reports.
2. Test reports.
3. Fusions reports. For each weld, provide an electronic and printed report of the downloaded information.

1.18 EQUIPMENT REQUIREMENTS:

A. General: Directional drilling equipment shall consist of a directional drilling rig with sufficient capacity to perform bore and pullback of pipe, a drilling fluid mixing, delivery and recovery system of sufficient capacity to successfully complete crossing, a drilling fluid recycling system to remove solids from drilling fluid so fluid can be re–used, a magnetic guidance system to accurately guide boring operations, a vacuum truck of sufficient capacity to handle drilling fluid volume, and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials, and spare parts on hand to maintain system in good working order for the duration of this project.

B. Drilling System:

1. Drilling Rig: Directional drilling machine shall consist of a hydraulically–powered system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. Machine shall be anchored to the ground to withstand pulling, pushing and rotating pressure required to complete crossing. The hydraulically–powered system shall be self–contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull–back pressure during pull–back operations. The rig shall be grounded during drilling and pull–back operations. There shall be a system to detect electrical current from the drill string and an audible alarm, which automatically sounds when an electrical current is detected.

2. Drill Head: The drill head shall be steerable by changing its rotation and shall provide necessary cutting surfaces and drilling fluid jets.

3. Mud Motors (if required): Mud motors shall be of adequate power to turn required drilling tools.

4. Drill Pipe: Shall be constructed of high–quality 4130 seamless tubing, Grade D or better, with threaded box and pins. Tool joints should be hardened to 32–36 RC.

C. Guidance System: A Magnetic Guidance System (MGS) probe or proven gyroscopic probe and interface shall be used to provide a continuous and accurate location of the drill head during drilling operation. The guidance shall be capable of tracking at all depths up to one hundred feet and in any soil condition, including hard rock. It shall enable driller to guide drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction). Guidance system shall be accurate to approximately 2% of vertical depth of the borehole at sensing position at depths up to 100 feet and accurate within 1.5 meters horizontally.

Bore Tracking and Monitoring:

At all times during the pilot bore the Contractor shall provide and maintain a bore tracking system that is capable of accurately locating the position of the drill head in the x, y, and z axes. The Contractor shall record these data at least once per drill pipe length or every twenty–five (25) feet, whichever is most frequent.

1. Downhole and Surface Grid Tracking System: Contractor shall monitor and record x, y, and z coordinates relative to an established surface survey bench mark. The data shall be continuously monitored and recorded at least once per drill pipe–length or at twenty–five (25) feet, whichever is more frequent.

2. Deviations between the recorded and design bore path shall be calculated and reported on the daily log. If the deviations exceed plus or minus 5 feet (horizontal or vertical deviation) from the design path, such occurrences shall be reported immediately to Owner and Engineer. The Contractor shall undertake all necessary measures to correct deviations and return to design line and grade.

3. Drilling Fluid Pressures and Flow Rates: Drilling fluid pressures and flow rates shall be continuously monitored and recorded by the Contractor. The pressures shall be monitored at the pump. These measurements shall be made during pilot bore drilling, reaming, and pullback operations.

Components: Contractor shall supply all components and materials to install, operate, and maintain the guidance system. This shall include, but not be limited to the following:

Probe and Interface
Computer, Printer and Software
DC Power Source, Current Control Box, and Tracking Wire

The Guidance System shall be a proven type such as Sharewell TruTracker MGS, or other proven guidance system, and shall be set up and operated by personnel trained and experienced with this system. The Operator shall be aware of any geo–magnetic anomalies and shall consider such influences in the operation of the guidance system.

D. Drilling Fluid (Mud) System:

1. Mixing System: A self–contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid composed of bentonite clay, potable water and appropriate additives. Mixing system shall be able to "molecularly shear" individual bentonite particles from the dry powder to avoid clumping and ensure thorough mixing. The drilling fluid reservoir tank shall be a minimum of 5000* gallons. Mixing system shall continually agitate the drilling fluid during drilling operations.

2. Drilling Fluids: Drilling fluids shall be composed of clean water and bentonite clay. Water shall be from an authorized source with a pH of 8.5

– 10. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and bentonite clay shall be mixed thoroughly and be absent of any clumps or clods. No additional material may be used in drilling fluid without prior acceptance from Engineer.

The bentonite mixture used shall have the minimum viscosities as measured by a March Funnel:

Rock, Clay	60 sec.
Hard Clay	40 sec.
Soft Clay	45 sec.
Sandy Clay	90 sec.
Stable Sand	80 sec.
Loose Sand	110 sec.
Wet Sand	110 sec.

* Engineer to modify as necessary, dependent upon project size.

These viscosities may be varied to best fit the soil conditions encountered, as accepted by the Engineer.

3. Delivery System: The mud pumping system shall have a minimum capacity of 500* GPM and be capable of delivering drilling fluid at a constant minimum pressure of 1,200 psi. The delivery system shall have filters in–line to prevent solids from being pumped into drill pipe. Connections between the pump and drill pipe shall be relatively leak–free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and conveyed to the drilling fluid recycling system. A berm, minimum of 12 inches high, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system to prevent spills into the surrounding environment. Pumps and/or vacuum truck(s) of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage and recycling facilities.

* Engineer to modify as necessary, dependent upon project size.

4. Drilling Fluid Viscosity:

In the event that inadvertent returns or returns loss of drilling fluid occurs during pilot hole drilling operations, Contractor shall cease drilling, wait at least 30 minutes, inject a quantity of drilling fluid with a viscosity exceeding120 seconds as measured by a March funnel and then wait another 30 minutes. If mud fracture or returns loss continues, Contractor shall cease operations and notify Engineer. Engineer and Contractor shall discuss additional options and work will then proceed accordingly.

5. Drilling Fluid Recycling System: The drilling fluid recycling system shall separate sand, dirt and other solids from drilling fluid and render drilling fluid reusable. Spoils separated from the drilling fluid will be stockpiled for later use or disposal.

6. Control of Drilling Fluids:

   The Contractor shall control operational pressures, drilling mud weights, drilling speeds, and any other operational factors required to avoid hydrofracture fluid losses to formations, and control drilling fluid spillage. This includes any spillages or returns at entry and exit locations or at any intermediate point. All inadvertent returns or spills shall be promptly contained and cleaned up. The Contractor shall maintain on–site mobile spoil removal equipment during all drilling, pre–reaming, reaming and pullback operations and shall be capable of quickly removing spoils. The Contractor shall immediately notify Engineer of any inadvertent returns or spills and immediately contain and clean up the return or spill.

E. Other Equipment:

1. Pipe Rollers: Pipe rollers shall be of sufficient size to fully support weight of the pipe while being hydro–tested and during pull–back operations. Sufficient number of rollers shall be used to prevent excess sagging of pipe.

2. Pipe Rammers: Hydraulic or pneumatic pipe rammers may only be used if necessary and with the authorization of Engineer.

3. Restrictions: Other devices or utility placement systems for providing horizontal thrust other than those previously defined in preceding sections shall not be used unless accepted by Engineer prior to commencement of the work. Consideration for acceptance will be made on an individual basis for each specified location. Proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete utility placement satisfactorily without undue stoppage and to maintain line and grade within tolerances prescribed by particular conditions of the project.

PART 2 – PRODUCTS

2.1 STEEL CASING:

A. The casing (if used) shall be new and unused pipe. The casing pipe shall be welded steel pipe, Schedule 30 or thicker and shall conform to ASTM A–139 and AWWA C200.

B. Pipe shall meet size and thickness required to complete the joint pull with an [FPVC] [HDPE] carrier pipe.

Minimum Steel Pipe Casing Dimensions for Ductile Iron Pipe

Carrier Pipe	Steel Casing Pipe Size	
I.D. (Nom.)	Pressure System	Gravity System
4	12	16

6	16	20
8	18	24
10	20	24
12	24	30
16	30	36
18	36	48
24	38	48
30	48	54
36	54	60

Minimum Steel Pipe Casing Dimensions for Fusible PVC Pipe

Carrier Pipe	Steel Casing Pipe Size	
I.D. (Nom.)	Pressure System	Gravity System
4	8	16
6	10	20
8	12	24
10	16	24
12	16	30
16	20	36
18	24	48
24	30	48
30	36	54
36	42	60

C. Fusible Polyvinylchloride (FPVC) Pipe – FPVC as specified in Section 02610 shall be used for this project.

D. The pipe and fitting manufacturer shall have an established quality control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rated, and contamination. The cell classification properties of the material shall be certified by the supplier, and verified by Manufacturer's Quality Control.

E. Delivery, Storage and Handling of Products:

2. Contractor shall inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, cracked linings, or other defects shall be rejected and removed from the job site without delay.

3. Unload and store opposite or near the place where the work will proceed with minimum handling. Store material under cover out of direct sun light.

Do not store directly on the ground. Keep all materials free of dirt and debris.

4. Contractor is responsible for obtaining, transporting and sorting any fluids, including water, to the work site.

5. Disposal of fluids is the responsibility of the Contractor. Disposal of fluids shall be done in a manner that is in compliance with all permits and applicable federal, state, or local environmental regulations. Contractor shall thoroughly clean entire area of any fluid residue upon completion of installation, and replace any and all plants and sod damaged, discolored, or stained by drilling fluids.

PART 3 – EXECUTION

3.1 GENERAL:

A. Contractor shall take precautions to protect the pipe during handling and assembly. Chains, hooks, or cable slings shall not be used to handle the pipe.

B. Care shall be used to protect the pipe from scarring, gouging, or excessive abrasion.

C. If pipe is stacked, stacking height shall not exceed the manufacturer's recommendations. Manufacturer's recommendation shall be followed in unloading, storing and protecting pipe.

D. The directional drilling procedure shall include provisions to guard against electrical shock such as ground mats, ground cables, hot boots and gloves. In addition, the drilling equipment shall include an alarm system capable of detecting electrical current as it nears electrical lines.

E. Contractor shall confirm all necessary permits, easements, and/or right–of–ways have been secured before beginning work.

F. The directional drilling method shall have mechanical fluid assistance. Pneumatic, water jetting, or mechanical (jack and bore) methods are not acceptable.

G. Contractor may make changes to proposed vertical and horizontal alignment of the installation and location of entry and exit points, provided these changes are submitted in writing to Engineer, and received acceptance of Engineer prior to construction.

H. Horizontal Directional Drilling operation is to be operated in a manner to eliminate the discharge of water, drilling mud and cuttings to adjacent creek or land areas involved during construction process. Contractor shall provide equipment and procedures to maximize the recirculation or reuse of drilling mud to minimize waste. All excavated pits used in the drilling operation shall be lined by Contractor with heavy–duty plastic sheeting with sealed joints to prevent migration of drilling fluids and/or ground water.

Contractor shall visit the site and must be aware of the close proximity of structures on either side of the crossing and provide Engineer with a drilling plan outlining procedures to prevent drilling fluid from adversely affecting these structures.

The general work areas on entry and exit sides of crossing shall be enclosed by a berm to contain unplanned spills or discharge.

Waste cuttings and drilling mud shall be processed through a solids control plant comprised as a minimum of sumps, pumps, tanks, desilter/desander, centrifuges, material handlers, and haulers all in a quantity sufficient to perform the cleaning/separating operation without interference with drilling program. The cuttings and excess drilling fluids shall be dewatered and dried by Contractor to extent necessary for disposal in off–site landfills. Water from dewatering process shall be treated by the Contractor to meet permit requirements and disposed of locally. The cuttings and water for disposal is subject to being sampled and tested. The construction site and adjacent areas will be checked frequently for signs of unplanned leaks or seeps.

Equipment (graders, shovels, etc.) and materials (such as groundsheets, haybales, booms, and absorbent pads) for cleanup and contingencies shall be provided in sufficient quantities by Contractor and maintained at all sites for use in the event of inadvertent leaks, seeps, or spills.

Waste drilling mud and cuttings shall be dewatered dried, and stockpiled so it can be loaded by a front–end loader, transferred to a truck, and hauled off–site to a suitable legal disposal site. The maximum allowed water content of these solids is 50% of weight.

Due to a limited storage space and environmental sensitivity at the worksites, dewatering and disposal work shall be concurrent with drilling operations. Treatment of water shall satisfy regulatory agencies before it is discharged.

I. Drill Path Survey: Entire drill path shall be accurately surveyed with entry and exit stakes placed in appropriate locations within the areas indicated on drawings. If Contractor is using a magnetic guidance system, drill path will be surveyed for any surface geo–magnetic variations or anomalies.

J. Environmental Protection: Contractor shall place silt fence between all drilling operations and any drainage, wetland, waterway or other area designated for such protection by contract documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. Contractor shall adhere to all applicable environmental regulations. Fuel may not be stored in bulk containers within 200 feet of any water–body or wetland.

The general work areas on the entry and exit sides of the crossing shall be enclosed by a berm to contain unplanned spills or discharge.

K. Safety: Contractor shall adhere to all applicable state, federal and local safety regulations and all operations shall be conducted in a safe manner. Safety meetings shall be conducted at least weekly with a written record of attendance and topic submitted to Engineer.

L. Pipe: Pipe shall be welded/fused together in one length, if space permits, with welds X–rayed prior to being placed in bore hole. Pipe will be placed on pipe rollers before pulling into bore hole with rollers spaced close enough to prevent excessive sagging of pipe.

3.2 JOINING FPVC PIPE AT ENDS OF DIRECTIONAL DRILLED SEGMENTS:

A. All joints at ends of directionally drilled line shall be fusion bonded to the proposed pipe section. Mechanical couplings are not permitted. Fusion bonded joints shall provide leak free service at the specified test pressure. See details.

B. Fusion bonding shall be accomplished as specified in Section 02610 – Fusible Polyvinylchloride (FPVC) Pipe.

3.3 DRILLING FLUID:

A. During the drilling, reaming, or pullback operations, Contractor shall make adequate provisions for handling drilling fluids for cutting entry and exit pits. To the greatest extent practical, these fluids must not be discharged into any waterway. When the Contractor's provisions for storage of the fluids or cuttings on site are exceeded, these materials shall be hauled away to a suitable legal disposal site. Contractor shall conduct directional drilling operation in such a manner that drilling fluids are not forced though the sub–bottom into any waterway. After completion of the directional drilling work, entry and exit pit locations shall be restored to original conditions. The Contractor shall comply with all permit provisions.

B. Pits at entry or exit point areas shall be constructed to completely contain the drill fluid and prevent its escape to any waterway or surrounding drainage system.

C. To the extent practical, Contractor shall maintain a closed loop drilling fluid system.

D. The Contractor shall minimize drilling fluid disposal quantities by utilizing a drilling fluid cleaning system, which allows returned fluids to be reused.

E. As part of the installation plan specified herein before, Contractor shall submit a drilling fluid plan which details types of drilling fluids, cleaning and recycling equipment, estimated flow rates, and procedures for minimizing drilling fluid escapes.

F. The composition of drilling fluid used shall be submitted to Engineer for acceptance prior to starting work. Fluids shall be inert and of no risk to the environment. No fluid will be accepted or utilized which does not comply with permit requirements and environmental regulations.

G. Drilling fluid shall remain in bore hole to increase stability of surrounding soil and to reduce the drag on the pulled pipe.

H. Disposal of drilling fluid and all other spoils shall be the responsibility of the Contractor at no additional cost to Owner and shall be conducted in compliance with all relative environmental regulations, right–of–way and work space agreements and permit requirements.

I. Drilling fluid returns at locations other then the entry and exit points shall be minimized. The Contractor shall immediately clean up any drilling fluid which inadvertently surfaces.

J. Excess drilling fluid shall be disposed of at a pre–permitted location found by Contractor. Contractor is responsible for transporting all excess fluids and other spoils to the disposal site and paying any disposal costs.

K. Drilling fluid shall not be discharged into sanitary or storm drain systems, ditches or waterways nor allowed to enter any wetland area or creek.

3.4 SUBSURFACE CONDITIONS:

A. Anticipated subsurface conditions at the crossing are described in soil borings attached. Borings are being provided for information only and the Owner and Engineer assume no liability for them or their interpretation.

B. Contractor must use its own experience and judgment in interpreting this data to prepare a proposal and/or perform the work.

3.5 EXISTING UTILITIES:

A. The Contractor must exercise caution in regards to existing utilities, including:

1. Verify location of all underground utilities.
2. Exposing any utilities which are to be crossed.
3. Modify drilling practices or down hole assemblies to prevent damage to adjacent underground and above ground utilities and structures.

B. The Contractor shall provide sheeting as necessary to protect adjacent structures.

3.6 DRILLING WATER AND RESTORATION:

A. Potable water is available at a cost to the Contractor in accordance with current utility company rate structure. Cost of transporting water to construction site is an expense of the Contractor.

B. Upon completion of pipe installation, the drilling pit and receiving pit shall be backfilled to original grade.

C. Restoration of any disturbed area shall be completed in accordance with these specifications.

3.7 SUB–AQUEOUS DIRECTIONAL DRILLING:

A. The pipe shall be directionally drilled, as shown on plans. Equipment used to pull the pipe shall be of sufficient size for this project.

Pilot hole shall be drilled along path shown on the Plan and Profile drawings to the following tolerances:

1. Vertical Location – Plus or minus 1 foot

2. Horizontal Location – Plus or minus 3 feet.

B. At the completion of pilot hole drilling, Contractor shall provide a tabulation of coordinates referenced to drilled entry point, which accurately describes location of pilot hole. This information shall be plotted on a 1" = 50' scale plan with a 1" = 50' horizontal and 1" = 2' vertical profile scales, compatible to the Drawings. This "as–built" plan and profile shall be updated as the pilot bore is advanced. The Contractor shall at all times provide and maintain instrumentation that will accurately locate the pilot hole and measure drilling fluid flow and pressure. Contractor shall grant Engineer access to all data and readout pertaining to position of the bore head and fluid pressures and flows. When requested, Contractor shall provide explanations of the position monitoring and steering equipment. Contractor shall employ experienced personnel to operate directional drilling equipment and, in particular, the position monitoring and steering equipment. No information pertaining to position or inclination of pilot bores shall be withheld from the Engineer.

Each exit point shall be located as shown with an over–length tolerance of 5 feet and an alignment tolerance of 3 feet left/right with due consideration of the position of other exit points. Alignment of each pilot bore must be approved by the Engineer before pipe can be pulled. If pilot bore fails to conform to above tolerances, Engineer has the option to require a new pilot boring be made.

C. A suitable cutting head shall be used to bore the face of excavation. Overcut of the excavation shall be minimized.

D. Reaming operations shall be conducted to enlarge pilot hole after acceptance of the pilot bore. The number and size of such reaming operations shall be conducted at discretion of the Contractor.

E. Joining Pipe:

1. FPVC carrier pipe shall be joined by thermal butt fusion as specified in Section 02610.

2. Steel casing pipe shall be welded (air tight) with a full penetration weld around the entire circumference. The weld shall not increase outside diameter by more than ¾". Joints shall be welded in accordance with AWWA C206–91 and applicable American Welding Society Standards.

F. Pipe Layout and Pullback:

1. Entire pipe length shall be laid out, welded and tested in one complete unit before being pulled back through the drill hole. Line pullback shall be continuous. Pipe shall be continuously lubricated during pullback and shall be laid on rollers or other suitable apparatus to facilitate pulling the pipe.

2. If pipe or its protective coating is damaged, it shall be replaced at no cost to the Owner.

3. **If pipe is placed at an incorrect location or cannot be advanced due to an unknown obstruction, the pipe shall be abandoned in place by filling with concrete. The cost of abandoning pipe shall be at Contractor's expense, except for pipe which must be abandoned due to an unknown obstruction.**

4. Pulling Loads: The maximum allowable pull exerted on FPVC pipelines shall be measured continuously and limited to maximum allowed by pipe manufacturer so pipe or joints are not overstressed.

5. Torsion and Stresses: A swivel shall be used to connect pipeline to drill pipe to prevent torsional stresses from occurring in the pipe.

6. Pipeline Support: The pipelines shall be adequately supported during installation to prevent overstressing or buckling.

7. Contractor shall at all times handle FPVC pipe in a manner which does not overstress the pipe. Vertical and horizontal curves shall be limited so that stresses do not exceed 50% of yield stress for flexural bending of the FPVC pipe. If pipe is buckled or otherwise damaged, the damaged section shall be removed and replaced at Contractor's expense. Contractor shall take appropriate steps during pullback to ensure the FPVC pipe will be installed without damage.

F. Contractor shall bleed all air out of the line.

3.8 SPECIAL CONSTRUCTION REQUIREMENTS FOR 24–INCH AND LARGER PIPE:

For [FPVC] [HDPE] pipe 24 inch and larger, unless approved otherwise by Engineer, a foundation bed of granular material (57 stone) shall be placed under and around all ductile iron fittings and valves for additional support of heavy system components. A foundation bed of granular material shall be provided for all valves 20 size and larger. For granular materials, the minimum vertical limit is 12 inches under the fitting or valve, up to 1/3 the overall height of the fitting or valve. The minimum horizontal limits of the granular material shall be 12 inches in all directions beyond the outer edges of the fitting or valve. The compaction of soils below the granular material shall be at 98% of the maximum density. Payment for this work shall be included in the associated fitting or valve unit cost. All spool pieces between 24 inch and larger ductile fittings and valves shall be at least 5 feet long. No joint deflection shall be allowed at the fittings or valves.

3.9 SWABBING:

The purpose of swabbing a new pipeline is to conserve water while thoroughly cleaning the pipeline of all foreign material, sand, gravel, construction debris and other items not

found in a properly cleaned system. Prior to pressure testing of a new pipeline swabbing shall be utilized as specified on the construction plans for each project.

All new water, wastewater force, and reclaim mains greater than 12" I.D. (with exceptions to smaller pipe lines as deemed necessary by Engineer) shall be hydraulically cleaned with a polypropylene swabbing device to remove dirt, sand and debris from main.

If swabbing access and egress points are not provided in the design drawings, it will be the responsibility of the CONTRACTOR to provide temporary access and egress points for the cleaning, as required.

Passage of cleaning poly swabs through the system shall be constantly monitored, controlled and all poly swabs entered into the system shall be individually marked and identified so that the exiting of the poly swabs from the system can be confirmed.

Cleaning of the system shall be done in conjunction with, and prior to, the initial filling of the system for its hydrostatic test.

The CONTRACTOR shall insert flexible polyurethane foam swabs (two pounds per cubic foot density) complete with rear polyurethane drive seal, into the first section of pipe. The swabs shall remain there until the pipeline construction is completed. Engineer shall be present for the swabbing process including swab insertion and retrieval.

The line to be cleaned shall only be connected to the existing distribution system at a single connection point.

Locate and open all new in–line valves beyond the point of connection on the pipeline to be cleaned during the swabbing operation.

At the receiver or exit point for the poly swab, the CONTRACTOR is responsible for creating a safe environment for collection of debris, water and the swab. Considerations shall be made for protecting surrounding personnel and property and safe retrieval of the swab.

Cleaning and flushing shall be accomplished by propelling the swab down the pipeline to the exit point with potable water. Flushing shall continue until the water is completely clear and swab(s) is/are retrieved.

After the swabbing process, pressure testing and disinfection of the pipe shall be completed in accordance with Section 3.12.

3.10 ON–SITE OBSERVATIONS OF WORK:

A. The Engineer or Project Representative shall have the right to require any portion of the work be completed in their presence. Any work covered up after such instruction shall be exposed by the Contractor for observation. However, if Contractor notifies Engineer or Project Representative such work is scheduled and they fail to appear within 72 hours, Contractor may proceed. All work completed and materials furnished shall be subject to review by the Engineer or Project Representative. All improper work shall be reconstructed, and all materials which do not conform to requirements of specifications, shall be removed from the work

upon notice being received from Engineer for rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

B. Contractor shall give Engineer or Project Representative a minimum of 72 hours notice for all required observations or tests.

C. It will also be required of Contractor to keep accurate, legible records of the location of all lines, valves, fittings, and appurtenances. These records shall be prepared in accordance with record drawing requirements of these Specifications. Final payment to the Contractor will be withheld until all such information is received and accepted. A disclaimer by the surveyor preparing As–Built drawings concerning location of underground lines will not be acceptable.

3.11 SAFETY:

A. Provide all necessary bracing, sheeting, bulkheads and shields to ensure complete safety to all traffic, persons, and property at all times during the work. Perform the work in such a manner as to not permanently damage existing structures or roadbeds.

B. Observe all applicable regulations of the authorities having jurisdiction over this site.

C. Perform all activities in accordance with Occupational Safety and Health Act of 1970 (PL–596), as amended, applicable regulations of Federal Government, OSHA 29 CFR 1926 and applicable criteria of ANSI A10 16–18, "Safety Requirements for the Construction of Tunnel Shafts and Caissons".

3.12 TESTING:

A. Disinfection tests:

1. All water pipe and fittings shall be thoroughly disinfected prior to being placed in service. Disinfection shall follow the applicable provisions of the procedure established for the disinfection of water mains as set forth in AWWA – Standard C651 entitled "AWWA Standard for Disinfecting Water Mains" and shall be in accordance with Chapter III. 1. – Section 350. Bacteriological testing on the water main shall be scheduled and completed by Contractor. Contractor will collect the water samples and be responsible for completing the water analysis (lab testing).

2. Temporary blow–offs shall be installed for the purpose of cleaning the water main. Blow–offs installed on water mains up to and including 12–inches shall be the same diameter as the water main. Blow–offs installed on 16–inch water mains and larger shall be the next smaller size, in diameter, than the water main being tested. Temporary blow–offs shall be removed and plugged after the main is cleared. The authorized representative shall be present prior to and during the operation of blow–offs. The main shall be flushed prior to disinfection.

3. The new water main shall be connected to the existing water main at one point only for flushing purposes (no looping). The new main MUST have a blow off on the end. After the new main is thoroughly flushed, the open end shall be sealed and restrained and the main shall be thoroughly disinfected. Anytime the new line is reopened (to repair defective joints or pipe, defective fitting or valve) the complete disinfection process shall be repeated. Once bacteriological clearance has been received from the regulatory authority, the new main may be pressure tested.

B. Pressure and Leakage Tests:

1. Contractor shall test pipelines installed under this Contract in accordance with these specifications prior to acceptance of the pipeline by the Engineer. All field tests shall be made in the presence of the Engineer. Except as otherwise directed, all pipelines shall be tested. Unless approved otherwise by Engineer, all fusible or butt weld joints shall be tested, including MJ adapter fittings associated with the new construction. All piping to operate under liquid pressure shall be tested in sections of approved length. If possible, the PVC and D.I.P. test sections shall be left exposed during the pressure test for visual leakage observation. For these tests, the Contractor shall furnish clean water, suitable temporary testing plugs or caps, and other necessary equipment, and all labor required. If the Contractor chooses to pressure test against an existing water main/valve, the new water main must be disinfected prior to connection to the new line. The Engineer will not be responsible for failure of the pressure test due to the existing valve leaking. Engineer may elect to furnish suitable pressure gauges for these tests. If not, the contractor will furnish suitable pressure gauges, calibrated by an approved testing laboratory, which increments no greater than 2 psi. Gauges used shall be of such size that pressures tested will not register less than 10% or more than 90% of the gauge capacity. All valved sections shall be hydrostatic tested to insure sealing (leak allowance) of all line valves. All HDD over 100 LF shall be air pressure tested (above ground) @ 5 PSI for a period of 15 minutes, prior to insertion. There shall be no pressure loss allowed.
2. Unless it has already been done, the section of pipe to be tested shall be filled with potable water and air shall be expelled from the pipe. Reclaimed water may be utilized for filling new reclaimed water or wastewater force main installations. If blow offs or other outlets are not available at high points for releasing air, the Contractor shall provide 1 inch (minimum taps and blow–off valves at the 12:00 position), as necessary. The cost of constructing blow–off valves and plugging them, after a successful pressure test, shall be included in the unit price bid amount for the pipe.

3. For mains larger than 20–inch size, the contractor shall profile (line and grade) the main after installation and prior to pressure and leakage test to accurately locate all high points. Field survey instrument (Level equipment) shall be utilized for this task. Blow off valves shall be installed (at a minimum) at all high points which offset vertically more than two pipe diameters in length (at a minimum). The contractor shall consult the design engineer on any technical questions or concerns.

4. Hydrostatic testing shall consist of a 150 psig test pressures, based on the elevation of the highest point of the line or section under tests. Pressure shall be applied by means of a pump connected to the pipe in a manner

satisfactory to the Engineer. The pump, pipe connection and all necessary apparatus shall be furnished by the Contractor and shall be subject to the approval of the Engineer.

5. Maximum duration for pressure test, including initial and final phase of the test, shall not exceed eight (8) hours. If the test is not completed due to leakage, equipment failure, etc., depressurize the test section, and then allow it to "relax" for at least eight (8) hours before bringing the test section up to test pressure again.

6. *Initial Phase of Pressure Testing*: First, all air must be removed from the test section. The pressure test shall be completed after the line is backfilled. If possible, all flanged or mechanical joint valves and fittings shall be left exposed for visual leak inspection. If possible all PVC and D.I.P. test sections shall be left exposed for visual leak inspection. Initially, the pressure within the test section should be raised to approximately 160 psi and then allowed to be idle (no additional make–up water/pressure to be injected), for approximately 3 hours. During this 3–hour period, the test section shall be allowed to stabilize and come to an equilibrium stage. No additional make–up water/pressure shall be applied to the test section during this 3–hour stabilization period unless the line pressure drops below 140 psi. In this case, make–up water/pressure shall only be applied to the test section to maintain a minimum of 140 psi (during the 3–hour stabilization period).

7. *Final Phase of Pressure Testing*: The final phase of the pressure test shall involve applying make–up water/pressure to achieve an "initial test pressure" of 150 psi (minimum)/155 psi (maximum). The test section is then allowed to be idle (no make–up water/pressure is added) for a period of 2 hours. After this 2–hour period, make–up water/pressure is applied and measured to re–establish the "initial test pressure". The quantity of water utilized to re–pump the line shall be measured and compared to the allowable quantities as determined by the table below. If the actual make–up water quantity is equal or less than the allowable amount, the pressure test passes. If the actual make–up water quantities are greater than the allowable amount, the pressure test fails (see table below).

Allowable Make Up Amount

Nominal Pipe Size (in)	**Make–up Water Allowance (GAL/LF of pipe), 2–hour test**
6	0.003
8	0.005
10	0.0065
12	0.0115
14	0.014
16	0.0165
18	0.0215
20	0.0275
22	0.035
24	0.044

26	0.05
28	0.0555
30	0.0635
32	0.0715
34	0.081
36	0.09
42	0.115
48	0.135
54	0.157

8. In the event a section fails to pass the tests, the Contractor shall do everything necessary to locate, uncover (even to the extent of uncovering the entire section), and replace the defective pipe, valve, fitting or joint. Visible leaks shall be corrected regardless of total leakage. Lines which fail to meet these tests shall be retested as necessary until test requirements are complied with. All testing shall be performed at the Contractor's expense.

9. If, in the judgment of Engineer, it is impracticable to follow the foregoing procedures exactly for any reason, modifications in the procedure shall be made with approval; but, in any event, the Contractor shall be responsible for the ultimate tightness of the piping within the above requirement. Re–disinfection shall be required if the line is de–pressurized for repairs prior to tying.

C. Locate Wire:

Two locate wires shall be provided on all installations. For HDD projects, locate wire shall be 12 AWG high strength copper–clad carbon steel with 45 mils (min) insulation. The external color shall be either blue for water, green for wastewater, purple for reuse, or black for raw water. Locate wire shall be brought to grade within a valve box or locate station box at all "entry point locations" and all "exit point locations". For HDD projects, there is no maximum length or interval between locate wire stations. The testing and report requirements within Chapter III. 1. – Section 350 and Chapter IV.3.–Section 429 shall be required except as modified herein. If both locate wires break or is not continuous (from end to end), the contractor shall, at the contractor's expense, provide soft–digs for the portions of the main with 12–feet or less cover (every 25 LF along main) to confirm as–built data. This soft–dig data shall be recorded on the as–built record drawings as specified here–in.

3.13 SITE RESTORATION:

Following drilling operations, Contractor will demobilize equipment and restore the worksite to its original condition. All excavations will be backfilled and compacted to 95 percent of original density. Landscaping will be the responsibility of Contractor.

3.14 RECORDKEEPING AND AS–BUILTS:

Contractor shall maintain a daily project log of drilling operations and a guidance system log with a copy given to Engineer at completion of project. As–built drawings shall be completed by a professional surveyor and certified as to accuracy by Contractor.

END OF SECTION