2015

STANDARD SPECIFICATIONS
WATER & SEWER SYSTEMS

CITY OF BUFORD, GEORGIA

Prepared by
Keck & Wood, Inc.

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SECTION 311000 - ROUTE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. City Code, including Development Regulations, Standard Drawings, Zoning Ordinance, Subdivision Regulations, Sewer Use Ordinance, Building Codes and Industrial Pretreatment Program, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing, abandoning designated utilities in place, and removing designated utilities.
7. Protecting above grade and underground improvements.
8. Restoring damaged improvements.
9. Temporary erosion and sedimentation control measures.

B. Related Sections:

1. Section 312000 “Trenching and Backfilling” for excavation and backfilling trenches for utility installation.

1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.

F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain the City's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the City and other authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by the City or other authorities having jurisdiction.

B. Improvements on Private Property: Obtain authority for performing route clearing indicated on private property before beginning Work.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and delivered to City's Public Works facility.

D. Utility Locator Service: Before commencing any route clearing work, notify the Utilities Protection Center "Call Before You Dig" to permit marking existing utilities on the ground in advance of the work. Do not begin any work until the required utility marking time has passed.

E. Do not commence route clearing operations until temporary erosion and sedimentation control measures are in place at least three hundred (300) feet in advance of clearing operations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Trenching and Backfilling."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed.

C. Protect existing site improvements to remain from damage during construction.

1. Provide barricades, coverings, or other types of protection necessary to prevent unnecessary damage to existing improvements.
2. Protect improvements on adjoining properties as well as those along the project route.
3. Restore damaged improvements to their original condition, as acceptable to the City or authorities having jurisdiction.
4. Replace property line monuments (such as iron pins) removed or disturbed by route clearing operations.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control plan, specifically prepared for the project, that complies with the City of Buford Erosion and Sediment Control Ordinance.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established and are effective.

D. When permanent controls are established and effective, remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Protect existing trees and other vegetation against unnecessary cutting, breaking or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip lines, excess foot or vehicular traffic, or parking of vehicles or equipment within drip line. Provide temporary fences, barricades or guards as required to protect trees and other vegetation to be left standing.

B. Provide protection for ornamental tree roots over one and one half (l½) inches diameter that are cut during any construction operation. Coat the cut faces with an emulsified asphalt, or other acceptable coating, especially formulated for horticultural use on cut or damaged plant tissues. Temporarily cover all exposed roots of ornamental trees with wet burlap to prevent roots from drying out; provide earth cover as soon as possible.

C. Repair or replace unnecessarily damaged trees and vegetation, as determined by the City, resulting from any construction operation, in a manner acceptable to the property owner and the City. Tree damage repair shall be performed by a qualified nurseryman. Replace unnecessarily damaged trees which cannot be repaired and restored to full-growth status, as determined by the tree surgeon.

3.4 ADJACENT PROPERTY PROTECTION

A. Protect improvements, trees and other vegetation on adjoining property as well as those on property requiring route clearing work.

B. Remove conflicting fences and provide effective temporary measures to prevent stock, cattle or other domestic animals from wandering to other lands. Reconstruct fences promptly.

C. Execute work so as not to create a nuisance to persons utilizing adjacent property.

D. Use work methods and provide temporary facilities as necessary to prevent washing, erosion, siltation or dust damage, or hazard to persons and property, within and off the work area.

3.5 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by the City or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify the City not less than two (2) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without the City's written permission.

3.6 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction. Accurately determine limitations of construction easements or right-of-way, and keep operations within such limits. Limit removal to the minimum practicable extent.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than 2 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.7 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil. Cut into maximum size which can be handled without tearing, striping sod and underlying topsoil, and stockpiling for use in restoring the surface area. Water sod and otherwise maintain sod in viable, growing condition.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil per City directions. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.

3.8 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off City's property.

1. Accomplish disposal of cleared materials daily, so as to maintain work route in a safe and neat condition throughout the construction period.

B. On-site Disposal Limitations:

1. Unless property owner requests complete removal, cut tree trunks and limbs, over two inches in diameter, into eighteen (18) inch lengths and neatly stack within work limits having same property ownership as that on which the tree originally grew.

2. On undeveloped property, process brush, trees and limbs less than two (2) inches in diameter, through a chipper and distribute evenly over the construction limits in a way as not to be objectionable to the property owner.
3. On developed property, remove all such clearing and grubbing waste and legally dispose of it off site.
4. Burning of cleared materials on the work site is not permitted.

END OF SECTION 311000

SECTION 312000 – TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. City Code, including Development Regulations, Sewer Use Ordinance, Building Codes and Industrial Pretreatment Program, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Excavating and backfilling trenches for utilities and pits for buried utility structures.
   2. Excavating and backfilling associated with utility abandonment and modification.

B. Related Sections:

   1. Section 311000 “Route Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 3/4 cu. yd. for trench and/or pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.4 QUALITY ASSURANCE

A. Codes and Standards: Perform trenching and backfilling work, including blasting, in compliance with applicable requirements of governing authorities having jurisdiction where such requirements exceed those specified in this Section.

1.5 FIELD CONDITIONS

A. Verify existing site grades to be substantially consistent with grades on Project Plans before commencing work. Report any significant conflict in grades to the City before proceeding with the work.

B. Subsurface conditions presented, if any, are not intended as representations or warrants of continuity of such conditions between soil borings or pits. It is expressly understood that the Contractor is solely responsible for interpretations or conclusions drawn there from. Data when made available are for the convenience of the Contractor who may perform additional test borings and other exploratory operations at the Contractor's expense, provided such operations are acceptable to the City.

C. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the City and other authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by the City or other authorities having jurisdiction.
3. Provide flaggers, barricades, warning signs, warning lights and other warning means as appropriate. When flaggers are utilized, individuals must meet requirements of Georgia Department of Transportation.
4. Maintain traffic on all roads and streets which must be crossed by trenching by making two separate cuts so that at least one traffic land is open at all times.
5. All traffic controls during construction must conform to Part 6 of the *Manual on Uniform Traffic Control Devices.*

D. Improvements on Adjoining Property: Obtain authority for performing trenching and backfilling indicated on private property before beginning Work.

E. Utility Locator Service: Before commencing any route clearing work, notify the Utilities Protection Center "Call Before You Dig" to permit marking existing utilities on the ground in advance of the work. Do not begin any work until the required utility marking time has passed.

1. Should unexpected piping or other utilities be encountered during excavation, consult utility owner immediately for direction. Cooperate with the City and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner.
2. Do not interrupt existing utilities serving occupied facilities except when authorized by the utility owner.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M 0; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

H. Sand: ASTM C 33/C 33M; fine aggregate.

I. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, six (6) inches wide and four (4) mils thick, continuously inscribed with a description of the utility; colored as listed below in subparagraph 2.2.B.1-5.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

1. Red: Electric.
2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls, which are specified in Section 311000 “Route Clearing," during earth-moving operations.

C. Open excavations within the roadway shall be covered with steel plates capable of handling H-20 loading at the end of each working day. Barricade open excavations outside of roadway limits and post warning lights for safety of persons. Operate warning lights during hours from dusk to dawn each day.

D. Take precautions and provide necessary bracing and shoring to guard against movement or settlement of existing improvements or new construction. Contractor is entirely responsible for strength and adequacy of bracing and shoring, and for safety and support of construction from damage or injury caused by the lack thereof or by movement or settlement.

E. Use work methods and provide temporary facilities as necessary to prevent washing, erosion, siltation or dust damage, or hazard to persons and property, within and outside the work area.

F. Place excavated material compactly alongside of trenches, and keep such material trimmed up so as to present the least practicable inconvenience to the public. Where necessitated by traffic conditions, remove from the roadway the first material excavated from a working length of trench so that further excavation is immediately used for backfilling, and thereby avoid stockpiling of material up on the roadway. Afterward, return first excavated material if needed for final backfilling.

G. Maintain all streets, sidewalks, crossings, fire hydrants, water and gas valves, fire alarm boxes, and other utilities accessible for their intended use except while the work is steadily advancing in the immediate vicinity of each such facility.

H. Keep every drain, gutter, culvert, sewer, and surface drainage route encountered, open for both temporary and permanent flow unless other effective provision for drainage is made.

I. Do not permit any hazardous condition to result from trenching and backfilling operations.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation. Remove water using dewatering methods which will prevent detrimental effects to stability of subgrades and foundations.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Provide and maintain pumps, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
3. Limit opening of additional trench to that which can be dewatered with available equipment or methods.

3.3 EXPLOSIVES

A. Explosives: Use explosives only as legally permitted and when other work methods are impractical.

B. Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

1. Perform blasting without damaging adjacent structures, property, or site improvements.
2. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

C. Assume sole responsibility for handling, storage, and use of any explosive materials.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.

1. If excavated materials intended for backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:

a. Six (6) inches beneath pipe in trenches, and twenty-four (24) inches wider than pipe.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:

a. Six (6) inches beneath pipe in trenches and the greater of twenty-four (24) inches wider than pipe or forty-two (42) inches wide.

3.5 PAVEMENT REMOVAL

A. Remove all pavement, including curb and gutter, sidewalk and the like, which must be disturbed by trenching operations.

B. Saw cut edges of bituminous pavement. For concrete pavement, saw cut edges or remove and replace to nearest joint when distance from cut edge to joint is less than eight (8) feet.

C. At sidewalks, curbs and gutters, and the like, remove entire sections between joints at trench crossing.

3.6 EXCAVATION FOR UTILITY STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus one (1) inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. General: Trenching consists of removal and disposal of material encountered to obtain required subgrade elevations, usually, but not necessarily limited to that incidental to the installation or modification of underground pipelines, structures and appurtenances.

B. Excavate trenches to indicated gradients, lines, depths, and elevations.

C. Excavated Material Storage: Locate and retain materials away from edge of the trench. Place satisfactory excavated material neatly alongside the trench, and keep such material trimmed up so as to present the least practicable inconvenience to the public. Where necessitated by traffic conditions, remove from the roadway the first material excavated from a working length of trench so that further excavation is immediately used for backfilling, and thereby avoid stockpiling material upon the roadway. Afterward, return first excavated material if needed for final backfilling.

1. Dispose of excess soil material and waste materials, such as rock, unsatisfactory excavated soil material, trash and debris, as specified hereinafter.

D. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

E. Stability of Excavation: Slope sides of excavations to comply with Subpart P of Part 1926 of the Occupational Safety and Health Act as amended. Should any provision of a governing local code be more stringent than the preceding national standard, follow the local code. Shore and brace or use trench box where sloping is not possible either because of space restrictions or stability of material excavated.

F. Shoring and Bracing: Provide portable trench boxes and materials for shoring and bracing, such as sheet piling, uprights, stringers, wales, and cross-braces, in good serviceable condition.

1. Maintain shoring and bracing and/or portable trench boxes in excavations regardless of time period excavations will be open. Carry down shoring and bracing and/or portable trench boxes as excavation progresses.
2. Provide trench boxes and/or shoring and bracing to comply with Subpart P of Part 1926 of the Occupational Safety and Health Act as amended. Should any provision of a governing local code be more stringent than the preceding national standard, follow the local code.

G. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to twelve (12) inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: Twelve (12) inches each side of pipe or conduit.

H. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes or conduit as determined by pipe or conduit foundation (bedding) requirements.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

I. Limit open trench excavation to a maximum of three hundred (300) feet ahead of completed backfill.

J. Maintain a horizontal separation of at least ten (10) feet between sanitary sewers and any existing or proposed water main. A sewer may be laid closer than ten (10) feet to a water main if it is laid in a separate trench or it is laid in the same trench with the water main located at one side on a bench of undisturbed earth.

K. Maintain a vertical separation of at least eighteen (18) inches between the crown of sanitary sewers and the invert of existing or proposed water mains with the sewer located below the water main. Where a vertical separation of eighteen (18) inches cannot be provided and the water main cannot be relocated to provide adequate clearance, center one full length of water main over the sewer so that both joints of the water main will be as far from the sewer as possible.

L. Remove rock, masonry and concrete material to a distance of at least six inches from all parts of pipe and appurtenances being installed.

3.8 SUBGRADE INSPECTION

A. Notify the City when excavations have reached required subgrade.

B. If the City determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the City.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavations under other construction, pipe, or conduit as directed by the City.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 UTILITY TRENCH BACKFILL

A. Place satisfactory soil backfill material in uniform layers, to required elevations. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill voids with satisfactory soil while removing shoring and bracing and/or trench boxes.

D. Initial Backfill:

1. Soil Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than one (1) inch in any dimension, to a height of twelve (12) inches over the pipe or conduit.

a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

E. Final Backfill:

1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.

F. Warning Tape: Install warning tape directly above utilities, twelve (12) inches below finished grade. Use detectable warning tape for all non-metallic utility lines.

3.12 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than eight (8) inches in loose depth for material compacted by heavy compaction equipment and not more than four (4) inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each utility.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Rights-of-way: Conform with the more stringent requirements of the permit issuing authority or right-of-way owner but not less than herein specified.
2. Roadways: Under and within five (5) feet horizontal distance of traffic using surfaces, compact each layer of backfill material to ninety-five (95) percent of maximum dry density.
3. Walkways: Under and within two (2) feet horizontal distance of paved walks, compact top six (6) inches of subgrade and each layer of backfill material to ninety-five (95) percent of maximum dry density.
4. Driveways and Parking Lots: Under and within two (2) feet horizontal distance of traffic using surfaces, compact each layer of backfill material to ninety-five (95) percent of maximum dry density.
5. Under Lawn or Unpaved Areas: Compact each layer of backfill or fill soil material to eighty-five (85) percent of maximum dry density.

3.14 FIELD QUALITY CONTROL

A. Provide quality control testing during construction as necessary to assure the entire earthwork, including all fill layers, subgrades, and bases meets specified minimums. Remove and reconstruct, or otherwise correct work which falls below specified density or is outside other specified limits.

B. Employ, at Contractor's expense, an independent testing agency to perform quality control testing during trenching and backfilling operations. The independent testing agency must be qualified according to ASTM E 329 to conduct soil materials testing, as documented according to ASTM D 3740 and ASTM E 548.

C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Perform tests at the following locations and frequencies:

1. Under structures, pavements, and driveways at least every 100 linear feet or less of pipeline, but in no case fewer than two tests.
2. Under walkways at least every 100 linear feet or less of pipeline, but in no case fewer than two tests.
3. Under turf of unpaved areas at least every 100 linear feet or less of pipeline, but in no case fewer than two tests.

D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

E. The City may perform sampling, surveying, inspection or testing activity during construction for City's use, but such activity does not relieve the Contractor from responsibility to achieve specified results.

F. When requested by the City, the Contractor shall provide quality control test reports including field density test reports and optimum moisture-maximum density curves to the City.

3.15 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.16 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of it in a manner acceptable to the City and in a manner that will not adversely impact the environment.

B. Transport surplus satisfactory soil to designated storage areas on City's property. Stockpile or spread soil as directed by the City; otherwise remove from the project work area and legally dispose of such material which cannot be acceptably distributed within the project work area.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off City's property.

3.17 RESTORATION

A. Plan and execute total work so as to minimize damage to property. Restore all surface materials, shrubbery, fences, lawns, walls, structures and other improvements to a condition no less desirable than that which existed before construction began.

B. Conduct all construction operations such that upon completion of any part of the work, the contour and topography of the construction area has not been substantially altered. No alteration of previously established storm drainage patterns will be permitted unless such alteration can be proven to the City’s satisfaction to improve the drainage pattern.

C. When necessary to temporarily remove or damage improvements of any significance, take good quality color photographs of such improvements before disturbing them. Make copies of such photographs available to the City on request.

D. Restore work area and accomplish site cleanup immediately after backfilling operations. Replace property line monuments damaged, disturbed or removed by trenching and backfilling operations.

END OF SECTION 312000

SECTION 330523 – TUNNELING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. City Code, including Development Regulations, Standard Drawings, Zoning Ordinance, Subdivision Regulations, Sewer Use Ordinance, Building Codes and Industrial Pretreatment Program, apply to this Section.

1.2 SUMMARY

A. Tunneling pertains to the installation of carrier pipe or tunnel liner below ground by means other than open cut excavation.

B. Tunnel liner and pipe sizes indicated on the Drawings and elsewhere in the Contract Documents are minimum nominal diameters. Use appropriate size and type of tunnel liner and pipe sizes and construction methods as necessary to provide a complete tunnel liner and pipe installation.

C. Related Sections:

1. Section 311000 “Route Clearing” for topsoil stripping and stockpiling.
2. Section 312000 “Trenching and Backfilling” for excavation of pits or trenches for tunneling operations.
3. Section 331100 “Water Systems” for installation of water mains, fittings, and appurtenances.
4. Section 333000 “Sanitary Sewer Systems” for installation of gravity sewers, force mains, fittings, and appurtenances.

1.3 JOB CONDITIONS:

A. Subsurface conditions presented, (if any), are not intended, as representations or warrants of continuity and it is expressly understood that the Contractor is solely responsible for any subsurface conditions that may arise.

B. Traffic Control: Schedule and conduct Work in a manner which will minimize inconvenience to vehicular and pedestrian traffic. Provide flagmen, barricades, warning signs, warning lights, and other warning means as appropriate. Maintain traffic on all roads and streets which must be crossed by utility lines. When flagmen are utilized, individuals must meet requirements of Georgia Department of Transportation. All traffic controls during construction must conform to Part 6 of the Manual on Uniform Traffic Control Devices.

C. Weather Limitations: Conduct all operations during weather conditions appropriate to the work being performed.

1.4 QUALITY ASSURANCE:

A. Codes and Standards: Comply with applicable provisions of the following, unless otherwise indicated:

1. AASHTO, Standard Specifications for Highway Bridges, Section 16 "Specification for Steel Tunnel Plates".
2. AISC, "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings", including the Commentary.
3. AREA, Manual for Railway Engineering, Section 4.12 "Specification for Steel Tunnel Liner Plates."

B. Supply all materials and perform all work in accordance with applicable American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI) or other recognized standards. Latest revisions of all standards are applicable. If requested by the City, submit evidence that manufacturer has consistently produced products of satisfactory quality and performance over a period of at least two years.

1.5 SUBMITTALS

A. Manufacturer's Data: For information, and as necessary to show compliance with these specifications, submit producer's or manufacturer's technical data and installation instructions for each product, including laboratory test reports, notarized certifications, or other data. Indicate by transmittal that a copy of each applicable instruction has been distributed to fabricators and installers. Include submittals for the following products:

1. Pipe Material
2. Pipe Jointing Details
3. Welding Rods and Procedure
4. Tunnel Liner Plate
5. Liner Plate Connection Bolts

B. For sectional plate tunnel liner, submit complete calculations required to analyze and design the tunnel liner plate system including applicable diagrams, nomographs, charts, and other data, each with appropriate explanations.

C. Where necessary, conform to Department of Transportation and railway company criteria, design data submitted must consist of the following:

1. Design data as required in AASHTO Design Specifications for Tunneling or AREA Manual for Railway Engineering as applicable.
2. Subsoil surveys including the elevation of the water table and the classification and relative density of the soils from the ground line to 3’ below the tunnel liner.
3. Where required, rock coring data including rock type and core recovery.
4. Water control plans where required.

D. Shop Drawings: For sectional plate tunnel liner construction, submit shop drawings showing complete details and schedules for fabrication and field erection.

E. Experience Submittals: Tunneling is deemed to be specialty contractor work. Provide evidence of a minimum of five continuous years of experience in tunneling construction for tunneling installer. Evidence of this experience must be provided with the shop drawings for review by the City.

1.6 STORAGE AND PROTECTION

A. All materials shall be stored and protected in accordance with the manufacturer's recommendations and as approved by the City.

PART 2 - PRODUCTS

2.1 CARRIER PIPE

A. Install all pipe in casings with restrained joint pipe meeting requirements specified in Section 331100 "Water Systems" and Section 333000 "Sanitary Sewer Systems." Where carrier pipe is installed without tunnel liner by tunneling methods, conform with carrier pipe material specifications unless otherwise indicated.

2.2 CASING PIPE TUNNEL LINER

A. Where tunnel liner is installed using jacking or boring construction methods, comply with the following material specifications for tunnel liner:

1. Steel Pipe Tunnel Liner, four (4) Inches and Smaller: ASTM A 53 material specifications. Use galvanized steel, Schedule 40 minimum, with threaded couplings.
2. Steel Pipe Tunnel Liner, Larger than 4 Inches: Conform to ASTM A53 or A139 material specifications, except hydrostatic testing is not required. Join pipe sections with full strength, continuous welds in accordance with procedures approved by the American Welding Society to obtain a watertight seal.
3. Unless otherwise indicated, use pipe with the minimum thickness requirements in the chart below. Actual thicknesses shall be determined by the casing installer, based on its evaluation of the required forces to be exerted on the casing when jacking. Any buckling of the casing due to jacking forces shall be repaired.
4. The nominal diameters of casing shown in the chart below are minimums. Larger casings, with the City's approval, may be provided for whatever reasons the Contractor may decide, whether casing size availability, line and grade tolerances, soil conditions, or other reasons.
5. Casing Sizes:

Under Railroads		
Carrier Pipe Diameter, inches	**Minimum Casing Diameter, inches**	**Minimum Wall Thickness, inches (Uncoated)**
6	16	0.375
8	18	0.375
10	20	0.375
12	22	0.375
14	24	0.407
16, 18	30	0.469
20, 24	36	0.532

Under State or County Roadways		
Carrier Pipe Diameter, inches	**Minimum Casing Diameter, inches**	**Minimum Wall Thickness, inches**
6	16	0.375
8	18	0.375
10	20	0.375
12	22	0.375
14	24	0.375
16, 18	30	0.375
20, 24	36	0.375

6. Reinforced Concrete Pipe Tunnel Liner: Conform to ASTM C76, Class V material specifications for withstanding in-place vertical loads. Provide additional reinforcement or strength required to withstand jacking pressure. Except for end closures, provide pipe in eight foot minimum lengths. Use self-centering tongue and groove joints such that outside of tunnel liner is uniform in diameter at all locations. Seal pipe joints with butyl based sealant manufactured for that purpose

2.3 SECTIONAL PLATE TUNNEL LINER

A. Where carrier pipe is installed in tunnel liner and mining methods are utilized, comply with the following specifications:

1. Materials: Fabricate tunnel liner sections of ASTM A569 corrugated steel plate especially manufactured for tunnel liner service. Design liner sections and fasteners in consideration of tunnel location. For liner plate design purposes, use soil, wheel, and surcharge loads of sufficient magnitude to insure a safe liner plate system in actual use conditions.
2. Provide tunnel liner plate having a minimum thickness of 0.179 inches and liner plate fasteners having a minimum diameter of 0.625 inches.

3. Fabrication: Tunnel diameters are in terms of the required minimum clear inside diameter of the erected liner plate tunnel. Fabricate liner plate sections so as to allow complete installation from within the tunnel, and with alternate liner plate rings in the erected tunnel containing two threaded grout holes in the vicinity of the tunnel invert and two grout bleed holes in the vicinity of the tunnel crown.
4. Galvanized Coating: After tunnel liner plate sections have been formed, punched, etc., hot dip galvanize plate sections with at least a two ounce coating of spelter per square foot total for both sides. Galvanized liner plates must not be warped, and the spelter coating must be free from defects such as blisters, flux, abrasion, poor adhesion and uncoated spots.
5. Bituminous Coating: After galvanizing, fully coat both sides of liner plate sections with an asphaltic bituminous coating not less than 0.05 inch thick and conforming to AASHTO N 190 for bituminous protected corrugated metal pipe.

2.4 VENT PIPING

A. Conform to ASTM A53 or A120 material specifications. Use two inch minimum Schedule 80 steel pipe with butt welded joints for vent construction.

B. Provide enamel primer and two coats exterior enamel paint in color(s) selected by the City for above grade piping.

2.5 CASING SPACERS

A. Provide casing spacers meeting one of the following requirements:

1. Type I Casing Spacers: Flanged, bolt-on style with a two-section stainless steel shell lined with a PVC liner, minimum 0.09-inch thick also having a hardness of 85-90 durometer. Attach runners to stainless steel risers properly welded to the shell. Manufacture the height of the runners and risers such that the pipe does not float within the casing.
2. Type II Casing Spacers: Two-section, flanged, bolt on style constructed of heat fused PVC coated steel, minimum 14 gauge band and 10 gauge risers, with 2-inch wide glass reinforced polyester insulating skids, heavy duty PVC inner liner, minimum 0.09-inch thick having a hardness of 85-90 durometer, and all stainless steel or cadmium plated hardware.

2.6 GROUT

A. Cement conforming to ASTM C 150, Type I or Type II. Grout shall have a minimum compressive strength of 100 psi attained within 24 hours. One part Portland Cement; two parts masonry lime; four parts mortar sand; two percent of an approved admixture of Bentonite, Septamin Stearex, or Hydrocide Liquid; and where required, a retardant. Use sufficient mixing water that will produce a workable mixture of grout capable of being pumped into the voids created by the tunneling.

2.7 CONCRETE

A. Conform with ASTM A 94 having minimum twenty-eight (28) day compressive strength of three thousand (3,000) psi.

2.8 CLAY BRICK

A. Conform with ASTM C 32, Grade MS or ASTM C32 sewer and manhole brick or ASTM C216 facing brick, Grade MW or SW, of nominal size 8 x 2-l/4 x 3-3/4 inches. Color and texture as selected by Contractor.

2.9 CONCRETE BRICK

A. Conform with ASTM C 55, Grade P-II, of nominal size 8 x 2-l/4 x 3-3/4 inches; gray-white concrete color with smooth formed natural texture.

2.10 Mortar Materials:

A. Cement: Portland Cement ASTM C 150, Type I or II.

B. Sand: ASTM C 144, well screened, clean, hard sharp, siliceous, free from loam, silt and other impurities. Provide the following grain size distribution:

1. #10 sieve, passing 95-100 percent
2. #50 sieve, passing 15-40 percent
3. #l00 sieve, passing 0-10 percent
4. Removal by decantation 0-5 percent

C. Water: Clean, fresh, free from oil, acid, organic matter and other deleterious substances.

D. Mortar Mix Proportions: Provide mortar mixed in the proportion of one part cement to three parts sand with only enough water to allow good workability of the mix. Hydrated lime may be added in amounts not exceeding 10 percent of the cement weight.

2.11 END SEALS

A. Flexible synthetic rubber boot conforming to ASTM C923 or Link Seal penetration seal with insulating plastic plate, galvanized bolts and nuts, and EPDM rubber element manufactured by Thunderline Corporation or approved equal.

2.12 SURFACE SETTLEMENT MARKERS

A. Surface settlement markers within pavement areas shall be P.K. nails. Surface settlement markers within non-paved areas shall be wooden hubs.

PART 3 - EXECUTION

3.1 GENERAL

A. Tunneling construction shall be performed so as not to interfere with, interrupt or endanger roadway or railway surface and activity thereon, and minimize subsidence of the surface, structures, and utilities above and in the vicinity of the tunneling. Support the ground continuously in a manner that will prevent loss of ground and keep the perimeters and face of the tunneling, passages and shafts stable. The Contractor shall be responsible for all settlement resulting from tunneling operations and shall repair and restore damaged property to its original or better condition at no cost to the City.

B. Face Protection: Protect the face of the excavation from the collapse of the soil into the tunnel liner or pipe.

C. Tunneling Design: Design of the bore pit and required bearing to resist jacking forces are the responsibility of the Contractor. The excavation method selected shall be compatible with expected ground conditions. Due to restrictive right-of-way and construction easements, casing lengths less than the nominal 20 foot length may be necessary.

D. State or County Roadway Crossing

1. The Contractor shall be held responsible for the coordinating and scheduling of all construction work within the roadway right-of-way and posting of appropriate permits.
2. Work along or across the transportation department rights-of-way shall be subject to inspection by such transportation department.
3. Perform all installations to leave free flows in drainage ditches, pipes, culverts or other surface drainage facilities of the roadway, street or its connections.
4. Do not place excavated material or equipment on the pavement or shoulders of the roadway without the express approval of the transportation department.
5. In no instance will the Contractor be permitted to leave equipment (trucks, backhoes, etc.) on the pavement or shoulder overnight. Place construction materials to be installed, which are placed on the right-of-way in advance of construction, in such a manner as not to interfere with the safe operation of the roadway.
6. The Contractor shall be responsible for providing sufficient information to obtain a blasting permit in a timely manner. The Contractor or subcontractor shall provide evidence of proper licenses prior to performing any blasting.

E. Railroad Crossings

1. Unless noted otherwise, the City will obtain the encroachment permit from the Railroad with supplemental information supplied by the Contractor as needed. However, the Contractor shall secure permission from the Railroad to schedule work so as not to interfere with the operation of the Railroad.
2. Additional insurance is required for each railroad crossing. The Contractor shall furnish the Railroad with such additional insurance as may be needed, cost of the same shall be borne by the Contractor.
3. All work on the Railroad right-of-way, including necessary support of tracks, safety of operations and other standard and incidental operation procedures may be under the supervision of the appropriate authorized representative of the Railroad affected and any

decisions of this representative pertaining to construction and/or operations shall be final and construction must be governed by such decisions.

4. If, in the opinion of the Railroad, it becomes necessary to provide flagging protection, watchmen or the performance of any other work in order to keep the tracks safe for traffic, the Contractor shall coordinate such work and shall reimburse the Railroad, in cash, for such services, in accordance with accounting procedures agreed on by the Contractor and affected Railroad before construction is started.
5. No blasting shall be permitted within the Railroad right-of-way.

3.2 EXCAVATION:

A. The following requirements are supplemental to the excavation section(s) of these specifications.

1. When required, excavate suitable pits or trenches for tunneling operations. Provide all necessary bracing, sheeting and/or other temporary means to insure safety of persons and property.
2. Maintain excavation free from water, mud and debris which will interfere with an efficient tunneling operation. Neatly dry-excavate material of whatever nature encountered within the tunnel. Do not use sluicing or jetting excavation techniques.
3. Limit excavation to the minimum diameter required for tunnel liner or casing pipe installation.
4. Pressure grout all excessive voids which may develop about the tunnel liner exterior.
5. Promptly backfill all pits and trenches.

3.3 GROUNDWATER CONTROL

A. Control the groundwater throughout the construction of the tunnel line or casing pipe.

B. Methods of dewatering shall be at the option and responsibility of the Contractor. Maintain close observation to detect settlement or displacement of surface facilities due to dewatering. Should settlement or displacement be detected, notify the City immediately and take such action as necessary to maintain safe conditions and prevent damage.

C. When water is encountered, provide and maintain a dewatering system of sufficient capacity to remove water on a 24 hour basis keeping excavations free of water until the backfill operation is in progress. Perform dewatering in such a manner that removal of soil particles is held to a minimum.

3.4 SAFETY

A. Provide all necessary bracing, 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 the roadway or railway or interfere with normal traffic over it.

B. Observe all applicable requirements of the regulations of the authorities having jurisdiction over this site. Conduct the operations in such a manner that all work will be performed below the level of the roadway or railway.

C. Perform all activities in accordance with the Occupational Safety and Health Act of 1970 (PL-596), as amended, applicable regulations of the Federal Government, OSHA 29CFR 1926 and applicable criteria of ANSI A10.16-81, "Safety Requirements for Construction of Tunnel Shafts and Caissons".

D. Bore pits shall not be left unattended unless proper safety barriers are in place.

3.5 SURFACE SETTLEMENT MONITORING

A. Provide surface settlement markers for tunnel liner and casing pipes 24-inches in diameter and larger. Place marker as specified and as directed by the City. Place settlement markers outside of pavement area, along the centerline of the casing at 20 foot intervals and offset 10 feet each way from the centerline of the casing. Also place markers at each shoulder of the roadway, at each edge of pavement, at the centerline of the pavement and at 10 and 25 feet in each direction from the centerline of the tunnel liner and casing pipe. Tie settlement markers to bench marks and indices sufficiently removed as not to be affected by the tunneling operations.

B. Make observations of surface settlement markers, placed as required herein, at regular time intervals acceptable to the City. In the event settlement or heave on any marker exceeds 1-inch, immediately cease work and using a method approved by the City and the authority having jurisdiction over the project site, take immediate action to restore surface elevations to that existing prior to start of casing operations.

C. Take readings and permanently record surface elevations prior to start of dewatering operations and/or shaft excavation. Use the following schedule for obtaining and recording elevation readings: all settlement markers, once a week; all settlement markers within 50 feet of the casing heading, at the beginning of each day; more frequently at the City's direction if settlement is identified. Make all elevation measurements to the nearest 0.01 foot.

D. Cooperate fully with jurisdictional personnel. Any settlement shall be corrected by, and at the expense of, the Contractor.

E. Promptly report any settlement and horizontal movement immediately to the satisfaction of jurisdictional personnel and the City and take immediate remedial action.

3.6 CASING PIPE INSTALLATION

A. Shaft

1. Conduct boring and jacking operations from a shaft excavated at one end of the section to be bored. Where conditions and accessibility are suitable, place the shaft on the downstream end of the bore.
2. The shaft shall be rectangular and excavated to a width and length required for ample working space. If necessary, sheet and shore shaft properly on all sides. Shaft sheeting shall be timber or steel piling of ample strength to safely withstand all structural loadings of whatever nature due to site and soil conditions. Keep preparations dry during all operations. Perform pumping operations as necessary.

3. The bottom of the shaft shall be firm and unyielding to form an adequate foundation upon which to work. In the event the shaft bottom is not stable, excavate to such additional depth as required and place a gravel sub-base or a concrete sub-base if necessary due to soil conditions.

B. Jacking Rails and Frame

1. Set jacking rails to proper line and grade within the shaft. Secure rails in place to prevent settlement or movement during operations. The jacking rails shall cradle and hold the casing pipe on true line and grade during the progress of installing the casing.
2. Place backing between the heels of jacking rails and the rear of the shaft. The backing shall be adequate to withstand all jacking forces and loads.
3. The jacking frame shall be of adequate design for the magnitude of the job. Apply thrust to the end of the pipe in such a manner to impart a uniformly balanced load to the pipe barrel without damaging the joint ends of the pipe.

C. Accomplish boring and jacking of casing pipes by the dry auger boring method without jetting, sluicing or wet boring.

D. Auger the hole and jack the casing through the soil simultaneously.

E. Bored installations shall have a bored-hole diameter essentially the same as the outside diameter of the casing pipe to be installed.

F. At contractor's option and to minimize abandoned tunnel liner, conduct initial boring using a pilot hole approximately 2 inches in diameter for the entire installation length. Verify required line and grade and use pilot hole as the center line of the larger hole to be bored. If rock is encountered in pilot hole, withdraw equipment and relocate tunnel location. Conduct pilot hole installation in revised location and repeat procedure. No extra payment will be considered for installations that encounter rock and must be abandoned.

G. Execute boring ahead of the casing pipe with extreme care, commensurate with the rate of casing pipe penetration. Boring may proceed slightly in advance of the penetrating pipe and shall be made in such a manner to prevent any voids in the earth around the outside perimeter of the pipe. Make all investigations and determine if the soil conditions are such as to require the use of a shield.

H. Any casing pipe damaged in jacking operations shall be repaired, if approved by the City, or removed and replaced at Contractor's own expense.

I. Lengths of casing pipe, as long as practical, shall be used except as restricted otherwise. Joints between casing pipe sections shall be butt joints with complete joint penetration, single groove welds, for the entire joint circumference, in accordance with AWS recommended procedures. Prior to welding the joints, the Contractor shall ensure that both ends of the casing sections being welded are square.

J. The Contractor shall prepare a contingency plan which will allow the use of a casing lubricant, such as bentonite, in the event excessive frictional forces jeopardize the successful completion of the casing installation.

K. Once the jacking procedure has begun, it should be continued without stopping until completed, subject to weather and conditions beyond the control of the Contractor.

L. Care shall be taken to ensure that casing pipe installed by boring and jacking method will be at the proper alignment and grade.

M. Perform tunneling such that the final tunnel liner position is within the following limits:

1. Lateral Alignment: Within one (1) percent of tunnel liner length.
2. Vertical Elevation: Within one half (0.5) percent of tunnel liner vertical grade, provided that the final grade of flow line is in the direction indicated on the drawings.

N. Maintain and operate pumps and other necessary drainage system equipment to keep work dewatered at all times.

O. Adequate sheeting, shoring and bracing for embankments, operating pits and other appurtenances shall be placed and maintained to ensure that work proceeds safely and expeditiously. Upon completion of the required work, remove the sheeting, shoring and bracing, unless otherwise approved by the City.

P. Remove all surplus material from the right-of-way and finish the excavation flush with the surrounding ground.

Q. Use grout backfill for unused holes or abandoned pipes.

R. Any replacement of carrier pipe in an existing casing shall be considered a new installation, subject to the applicable requirements of these Specifications.

3.7 MINING:

A. When installing tunnel liner by mining methods, handle, maintain, and install liner plate sections in such manner as to avoid damage to plates and surface coating thereon. Install liner plates immediately after excavated material is removed from the tunnel. Do not permit liner plate installation to fall more than 24 inches behind the tunnel working face. Do not leave more than 12 inches of unlined tunnel at the end of the day's operation.

B. Provide all necessary bracing bulkheads and/or shields required to insure safety of persons and property. Provide well braced, temporary bulkhead against excavation face during each cessation of work while the heading is within 20 feet of railroad tracks or roadway pavement.

C. Pressure grout voids between excavated tunnel bore and liner plate at least daily as tunnel excavation and liner plate installation proceeds. In addition, do not extend liner plate installation more than 10 feet without placing grout. Introduce grout through all grout holes in tunnel liner plate at or near tunnel invert, continue grouting until grout mixture bleeds through grout holes located at tunnel crown. Use grouting pressure sufficient to fill all voids.

D. Perform tunneling such that the final tunnel liner position is within 0.2 feet of specified position, both laterally and vertically.

3.8 FREE BORING

A. Where the Drawings indicate a pipeline is to be installed by boring without casing, construct the crossing by the free bore method. Accomplish the free bore method by the dry auger boring method without jetting, sluicing, or wet boring.

B. The diameter of the free bore shall not exceed the pipe bell outside diameter or the pipe barrel outside diameter plus 1-inch, whichever is greater.

C. Free boring, where indicated on the Drawings, is to be performed at the Contractor's option. The Contractor may choose to construct the crossing by the conventional bore and jack casing pipe method without any additional cost than required for free boring.

D. The Contractor shall be responsible for any settlement of the roadway caused by the free bore construction activities.

3.9 ABANDONMENT:

A. Should it become necessary to abandon a tunnel for any reason, pressure grout the abandoned hole to prevent damage to surrounding earth and structures. When the tunnel liner is retained, fill entire tunnel with grout and pressure grout any voids about the tunnel liner exterior.

3.10 TUNNEL LOCATIONS:

A. Locate tunnels as indicated, or as directed by the City.

B. To facilitate construction, changes in tunnel location may be permitted. Proposed changes must be submitted by the Contractor. Changes in location must be acceptable to the City, and any utility company or public agency having jurisdiction over the location.

3.11 VENTILATION AND AIR QUALITY

A. Provide, operate and maintain for the duration of tunneling activities a ventilation system to meet safety and OSHA requirements.

B. Construct vents for tunnel liners or casing pipe of all natural gas crossings as indicated and as required by any utility company or public agency having jurisdiction over the location.

3.12 ROCK EXCAVATION

A. In the event that rock is encountered during the installation of the casing pipe which, in the opinion of the City, cannot be removed through the casing, the City may authorize the Contractor to complete the crossing by an alternate method established in a change order.

3.13 INSTALLATION OF PIPE

A. After construction of the tunnel liner or casing pipe is complete, and has been accepted by the City, install the carrier pipeline in accordance with the Drawings and Specifications.

B. Check the alignment and grade of the tunnel liner or casing pipe and prepare a plan to set the pipe at proper alignment, grade and elevation, without any sags or high spots.

C. Hold the carrier pipe in the casing pipe by one of the following methods:

1. The carrier pipe shall be held in the casing pipe by the use of hardwood blocks spaced radially around the pipe and secured together so that they remain firmly in place. The spacing of such blocks longitudinally in the casing pipe shall not be greater than 10 feet.
2. The pipe shall be supported within the casing by use of casing spacers sized to limit radial movement to a maximum of 1-inch. Provide a minimum of one casing spacer per nominal length of pipe. Attach casing spacers to the pipe at maximum 18 to 20 foot intervals.

3.14 END SEALS

A. Seal ends of tunnel liner or casing pipe to prevent debris and moisture from entering the annular space between the carrier pipe and tunnel liner. For casing pipe tunnel liner, provide end seal consisting of flexible synthetic rubber boot conforming to ASTM C-923 or Link Seal penetration seal with insulating plastic plate, galvanized bolts and nuts, and EPDM rubber element manufactured by Thunderline Corporation, or approved equal.

END OF SECTION 330523

SECTION 330525 – DIRECTIONAL DRILLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. City Code, including Development Regulations, Standard Drawings, Zoning Ordinance, Subdivision Regulations, Sewer Use Ordinance, Building Codes for Industrial Pretreatment Program, apply to this Section. *Minimum Standards for Public Water Systems*, latest edition, published by the Georgia Environmental Protection Division also apply to this Section.

1.2 DESCRIPTION OF WORK:

A. The directional drilling method of installation shall be used at the locations shown on the drawings and at locations where the Contractor elects to utilize directional drilling out of convenience.

B. Directional drilling operations include, but are not limited to, all earthwork associated with the installation of pipe, protection of all underground utilities and appurtenances and restoration of any damaged improvements.

C. Related Work Specified Elsewhere:

1. Section 311000 “Route Clearing” for topsoil stripping and stockpiling.
2. Section 312000 “Trenching and Backfilling” for excavation of pits or trenches for directional drilling operations.
3. Section 331100 “Water System” for installation of water mains, fittings, and appurtenances.
4. Section 333000 “Sanitary Sewer System” for installation of gravity sewers, force mains, fittings, and appurtenances.

1.3 JOB CONDITIONS:

A. Verify existing site grades to be substantially consistent with grades shown on the Drawings before commencing work. Report any significant conflict in grades, which would alter work as specified in specifications and shown on drawings to the Engineer before proceeding.

B. Subsurface conditions presented, (if any), are not intended, as representations or warrants of continuity and it is expressly understood that the Contractor is solely responsible for any subsurface conditions that may arise.

C. Weather Limitations: Conduct all operations during weather conditions appropriate to the work being performed.

1.4 QUALITY ASSURANCE:

A. Directional Drilling is considered to be a specialty contractor work. The Contractor shall provide evidence of its ability to perform the Work by documentation of successful completion of drills similar to that shown on the Drawings. Utilize drilling machines of sufficient capacity as needed to perform the specified drilling.

PART 2 - PRODUCTS

2.1 Materials:

A. Provide all materials, products, and accessories required for complete properly functioning system.

2.2 Directional Drilling Piping System:

A. Drilling Alignment: As per Drawings and as per pipe manufacturer's recommended bend radius.

B. Drilling Tolerances: The Contractor shall supply to the City a plan and profile of the proposed directional drilling prior to commencing this operation if it differs from the Drawings. The Contractor must receive approval from the City on the new proposal prior to commencing work. In no case shall the Contractor's proposal or final alignment be at a higher elevation than shown on the Drawings.

PART 3 - EXECUTION

3.1 GENERAL:

A. Interpreting subsurface investigation reports and data, investigating the project site and determining the site soil conditions is the sole responsibility of the Contractor. Any subsurface investigation by the Contractor must be approved by the authority having jurisdiction over the site.

B. The Drawings are generally schematic, and it is required that the Contractor extend and/or modify construction details, as approved by the City, when field conditions necessitate such changes to achieve a safe and properly functioning system.

C. Conduct operations in such a manner as to assure a system free of leakage and protection of pipe during installation.

D. Unless otherwise instructed, install pipe by accepted industry standards for drilling and installation of pipe.

3.2 PIPE HANDLING:

A. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe and pipe coating. If the pipe must be stacked for storage, such stacking should be done in accordance with the pipe manufacturer's recommendations. The handling of the pipe should be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.

B. Where directional drilling is required under railroads, highways, streets, or other facilities, construction shall be done in the manner that will not interfere with the operation of the facility, and shall not weaken the roadbed or structure. No roadway pavement, subgrade, roadbed, paved shoulder, or unpaved median shall be disturbed or excavated as part of the pipe placing operation for any reason without written authorization by the City. In the above areas, any broken or damaged boring rod/stem, boring head (including transmitter/transponder locating heads and cutter heads), couplings (including backreaming, swivel or connector couplings), or any other material that cannot be retrieved as part of the pullback operation shall become the property of the property owner and shall be abandoned in place unless otherwise authorized in writing by the City.

C. Once the directional boring is begun, the operation shall be carried on without interruption, insofar as practical.

3.3 METHOD OF DRILLING:

A. Employ a horizontal directional drill machine of sufficient size to complete the untrenched crossing. Drill pilot hole through the soil at the proper entrance angle and follow the drill profile to the exit location.

B. In unconsolidated soil formations, pump a drilling fluid or slurry of at least 10% high grade Bentonite, or approved equal, to consolidate excavated materials, to seal the walls of the hole and to furnish lubrication for subsequent materials and equipment. Continuously monitor and adjust the pressure of the drilling fluid to ensure that ground surface disruption and fluid migration and spillage are prevented.

C. Contain and/or remove excess drilling spoils from both ends of the directional drill and any surface "break-outs" with the use of a vacuum truck and holding tanks or other acceptable means. Utilize relief holes and other measures to obtain controlled "break-outs".

D. Any voids that develop and are deemed by the City to be detrimental to the Work or adjacent facilities or environment are to be pressure grouted with an acceptable mix.

E. Enlarge the pilot hole to a suitable size for the pipe to be installed by pulling a reamer back through the hole. For larger diameter pipes, prereaming the hole by pulling successively larger reamers through the hole may be required.

F. After reaming the hole to a sufficient size, attach the length of line pipe to be installed to the reamer. Utilize a swivel attached to the reamer to prevent excessive rotation of the line pipe. During pullback, rotate drill pipe while circulating drilling fluid, as needed. Place line pipe on rollers above the ground or lift pipe with side booms. Inspect pipe coating for holidays using a holiday detector. Repair and re-inspect holidays until none are present.

G. If the drill rod and line pipe becomes stuck in the hole, forcing the pipe through the hole by pushing on the exposed end of the pipe will not be permitted. All forces required to pullback the pipe must be generated by the drilling machine.

H. After pipe pullback is complete, check pipe coating on first ten-foot section of pipe for holidays in the presence of the City. If a holiday is detected, the directional drill will not be accepted.

I. After completion of successful pipe installation, backfill excavation and clean up staging areas as soon as possible.

J. Provide accurate Record Drawings of each directional drill installation. Provide plan and profile showing location and elevation at 50-foot intervals for the length of the directional drill installation. Record data for the profile during the drilling with capable locating equipment.

END SECTION 330525

SECTION 331100 – WATER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. City Code, including Development Regulations, Standard Drawings, Zoning Ordinance, Subdivision Regulations, Sewer Use Ordinance, Building Codes for Industrial Pretreatment Program, apply to this Section. *Minimum Standards for Public Water Systems*, latest edition, published by the Georgia Environmental Protection Division also apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Foundation preparation.
2. Furnishing and laying water pipe.
3. Furnishing and installing water line appurtenances.
4. Furnishing and laying services and accessories.
5. Cleaning and sterilizing constructed work.
6. Testing constructed work.

B. Related Sections include the following:

1. Section 311000 “Route Clearing” for topsoil stripping and stockpiling.
2. Section 312000 “Trenching and Backfilling” for excavation and backfilling trenches for utility installation.
3. Section 330523 “Tunneling” for utility line construction.
4. Section 330525 “Directional Drilling” for utility line construction.

C. Utility furnished products include water meters that will be furnished to the site, ready for installation.

1.3 DEFINITIONS

A. DIP: Ductile iron pipe.

B. PVC: Polyvinyl chloride plastic.

C. HDPE: High –Density Polyethylene.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1. When requested by the City, provide producer's or manufacturer's specifications and installation instructions (where appropriate) for the following products, including laboratory test reports, notarized certifications, or other data as may be required to show compliance with these Specifications, including specified standards:

    a. Pipe, tubing, fittings and joints.
    b. Valves.
    c. Service Accessories.
    d. Fire hydrants.
    e. Granular material for pipe bedding.

B. Operation and Maintenance Data: Prior to final acceptance of a Project by the City and after equipment installation is complete, submit four (4) copies of manufacturer's operation and maintenance literature, warranties, and other information as required by the City for all altitude valves, pressure regulators, and backflow preventers.

1.5 QUALITY ASSURANCE

A. Manufacturer:

1. Furnish manufactured items, fittings, valves, and service components, from manufacturers having regularly produced such items as specified herein which have proven satisfactory in actual service, over at least a two (2) year period, as determined by the City.

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

C. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

D. NSF Compliance:

1. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

E. Imperfections:

1. Irregardless of tolerances permitted by industry standards specified herein, the City may reject pipe or appurtenances at the manufacturing plant or project site, which have cracks, chips, blisters, lack of smooth interior or exterior surface, evidence of structural weakness, porosity, joint defect, significant variation from theoretical shape, or other imperfection which might, in the opinion of the City, contribute to a reduced functional capability, accelerated deterioration, or reduced structural strength.

F. Repairs:

1. Do not install used, patched, or repaired pipe or appurtenances.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including yard hydrants, according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.
2. Protect valves against damage to threaded ends and flange faces.
3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including yard hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by City or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify City no fewer than seventy-two (72) hours in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without City's written permission.

B. Licensing:

1. All work specified in this section, except for water system service line installation, is to be performed by a contractor with a valid Utility Contractor’s license issued by the State of Georgia. Water service line installation may be performed by either a contractor with a valid Georgia Utility Contractor’s license or by an individual having a valid Master Plumber’s license issued by the State of Georgia.

C. Traffic Control:

1. Schedule and conduct Work in a manner which will minimize inconvenience to vehicular and pedestrian traffic. Provide flagmen, barricades, warning signs, warning lights, and other warning means as appropriate. When flaggers are utilized, individuals must meet the requirements of Georgia Department of Transportation. Maintain traffic on all roads and streets which must be crossed by water lines and making two separate cuts so that at least one traffic lane is open at all times. All traffic controls during construction must conform to Part VI of the Manual on Uniform Traffic Control Devices, latest edition.

D. Connection to Existing Pipework:

1. Where it is required that connection be made to existing pipework, expose existing piping and determine the exact fittings and/or other appurtenances necessary to make the connection. Connections to existing pipework indicated on drawings (if any) are shown only for the purpose of illustrating the general type of connection desired, and no assurance exists that such illustration can be followed precisely.

E. Weather Limitations:

1. Conduct all operations during weather conditions appropriate to the work being performed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide all materials, products and accessories required for complete, properly functioning system. Use only those pipe, fitting, valve and accessory materials that meet National Sanitation Foundation Standard 61 (NSF 61) requirements. When requested, furnish evidence of NSF 61 compliance.

2.2 DUCTILE-IRON PIPE AND FITTINGS (DIPW-1)

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Pressure Class: Min. 350 Pressure Class.
2. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110/AWWA C111, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and corrosion resistant alloy steel bolts. Gaskets shall not be made of natural rubber or any other material which will support microbial growth. Lubricants which support microbial growth shall not be used. The use of vegetable shortening to lubricate joints is prohibited.
4. Provide mechanical joints for direct burial piping or concealed piping within structures, or, at Contractor opinion, for direct burial piping outside structures.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151/AWWA C111, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Pressure Class: Min. 350 Pressure Class.
2. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
3. Gaskets: AWWA C111, rubber.
4. Provide push-on joints for direct burial piping outside structures.

C. Restrained Joint (RJ): AWWA C110/AWWA C111Factory fabricated joint restraint system to resist pressurized pipe thrust forces.

1. Push-on Type Joint: Use boltless system of rubber gasket embedded with equally spaced stainless steel segments to grip the pipe, with allowance for joint deflection, and rated for minimum 250 psi working pressure.
2. Mechanical Joint: Use assembly of ductile iron retainer gland and corrosion resistant alloy steel bolts and nuts having a minimum 250 psi working pressure rating and permitting joint deflection and with a minimum safety factor of 2:1.
3. Provide restrained joints for piping installed in tunnel liner, where indicated on the Drawings and, at Contractor option, for direct burial piping thrust restraint in lieu of concrete and metal tie rods and bands.

D. Flanged Joint (FJ): ANSI/AWWA C115/A21.15 ductile iron flanged joint complying with ANSI B16.1 for class 125 pound drilling, unless class 250 pound drilling is indicated on drawings or is required for connecting valves.

1. Use corrosion resistant alloy steel bolts and nuts, and rubber gaskets complying with Appendix A to ANSI/AWWA C115/A21.15.
2. Provide flanged joints for normally visible piping, unless noted otherwise.

E. Grooved Joint (GJ): Where indicated on the drawings provide bolted coupling utilizing grooved and shouldered pipe ends complying with AWWA C606, and suitable for not less than 150 psig working pressure while permitting angular and restrained longitudinal flexibility of connecting pipe.

1. Use corrosion resistant steel alloy bolts and nuts, molded or extruded elastomeric gasket material recommended by manufacturer for actual service application required.
2. Use malleable or ductile iron housing with fusion bonded epoxy outside coating.
3. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.

2.3 DUCTILE- IRON PIPE AND FITTINGS (DIPW-2)

A. Pipe (Ball Joint): Ductile iron pipe conforming with ANSI/AWWA C151/A21.51, suitable for minimum 250 psig water working pressure and with wall thickness not less than tabulated below:

Nominal Pipe Dia.-Inches	Min. AWWA C151 Special Thickness Class
4, 6	54
8, 10	55
12, 14	56

Nominal Pipe Dia.-Inches	Min. AWWA C151 Special Thickness Class
16	57
18	58

1. Provide non-floating pipe with additional wall thickness, which with accessories and cement lining results in at least ten (10) percent negative buoyancy when pipe is under water and full of air.

B. Pipe Lining: Provide cement mortar pipe lining complying with ANSI/AWWA C104/A21.4 and standard asphaltic coating over lining and pipe exterior. Do not use any material which imparts taste or odor to potable water, or which is toxic to humans.

C. Joints: Boltless, flexible type joints permitting deflections up to fifteen (15) degrees without damage to pipe or joint. Construct joints of high strength, corrosion resistant, alloyed cast steel or ductile iron with flexible gasket which safely permits high end-pull forces required for handling and installing pipe. Utilize joint design which under actual service conditions is free of measurable leakage of water into or out of piping installation.

2.4 COPPER TUBE AND FITTINGS (CUTW-1)

A. Hard Copper Tube: ASTM B 88, Type L, water tube, annealed temper, working pressure up to 200 PSIG at 200°F water temperature. Use for all other installations.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type, working pressure up to 160 PSIG at 100°F water temperature or cast bronze pressure fittings. Furnish only wrought-copper fittings if indicated.

B. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper, working pressure up to 200 PSIG at 200°F water temperature. Use for underground direct burial installations.

1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type, working pressure up to 160 PSIG at 100°F water temperature or flare type cast bronze pressure fittings complying with ASME B16.26. Furnish only wrought-copper fittings if indicated.

2.5 POLYVINYL CHLORIDE PIPE AND FITTINGS (PVCPW-1):

A. General: PVCPW-1 can only be used for pipe sizes under nominal six (6) inch diameter.

B. PVC, Class 200 (SDR 21) Pipe: Non-toxic, polyvinyl chloride compound meeting ASTM D 1784, Class 12454-A or B material specification, and further meeting requirements of the National Sanitation Foundation.

1. Furnish pipe with each section continuously and permanently marked with the following identifying data:

a. Nominal size and outside diameter.
b. Material code designation.
c. Dimension ratio number (SDR or DR).
d. Pressure class.
e. ASTM or AWWA specification designation.
f. Manufacturer's name or trademark and production record code.
g. National Sanitation Foundation Seal (NSF) verifying suitability of pipe material for potable-water service.

2. Fittings (PVC): Manufactured from same material compound as pipe, and in such configuration as necessary to achieve long term water pressure rating not less than the connecting pipe or not less than 160 PSI at 73 F with a safety factor of 2.5:l.

3. Fittings (Gray or D.I. Fittings): Gray or ductile iron fittings complying with ANSI A21.10 or A21.11 for minimum 250 PSIG pressure rating. At contractor's option, ductile iron compact fittings complying with ANSI A21.53 for minimum 350 PSIG pressure rating may be used. Provide cement mortar interior lining complying with ANSI A21.4, and manufacturer's standard bituminous coating over lining and fitting exterior. Do not use any lining or coating which imparts taste or odor to potable water, or which is toxic to humans.

4. Joints (PVC Pipe): Unless otherwise shown or required, use flexible elastomeric seals conforming to ASTM D 3139 and ASTM F 477. Provide compatible gaskets or adapters as required when joining to different type pipe material.

5. Joints (Gray or D.I. Fittings): Comply with ANSI A21.11 and unless otherwise shown or required, use at contractor's option push-on type joint or mechanical joint utilizing corrosion resistant alloy bolts. Provide gaskets or adapters compatible with connecting pipe as required.

2.6 POLYVINYL CHLORIDE PIPE AND FITTINGS (PVCPW-2):

A. General: PVC Piping System Type 2 is to be used for open cut installation of plastic piping which is six (6) to twelve (12) inches in diameter.

B. PVC, Class 305 (SDR 14) Pipe: Non-toxic, polyvinyl chloride compound meeting ASTM D 1784, and conforming to the requirements of AWWA C900, with ductile iron outside diameter.

1. Fittings: Gray or ductile iron fittings complying with AWWA C110/AWWA C111, and minimum 250 PSIG pressure rating; or, at Contractor's opinion, compact fittings complying with AWWA C153 with minimum 350 PSIG pressure rating. Provide cement mortar interior lining complying with ANSI A21.4, and manufacturer's standard bituminous coating over lining and fitting exterior. Do not use any lining or coating which imparts taste or odor to potable water, or which is toxic to humans.

2. Joints: Comply with ANSI A21.11, and unless otherwise shown or required, use at contractor option push-on type joint or mechanical joint utilizing corrosion resistant alloy bolts.

2.7 HIGH-DENSITY POLYETHYLENE PIPE AND FITTINGS (HDPE-1)

A. General: HDPE Piping System Type 1 is to be used for Horizontal Directional Drilling installation of plastic piping which is four (4) to eighteen (18) inches in diameter.

B. Furnish pipe with each section continuously and permanently marked with the following identifying data:

1. Nominal size and outside diameter.
2. Material code designation.
3. Dimension ratio number (SDR or DR).
4. Pressure class.
5. ASTM or AWWA specification designation.
6. Manufacturer's name or trademark and production record code.
7. Blue color stripes or print lines to designate potable water.

C. High Density Polyethylene Piping System Type DR-9 and conforming to the requirements of AWWA C906 and ASTM F714.

1. Molded Fittings: Molded Fittings shall be manufactured and tested in accordance with ASTM D3261, and tested in accordance with AWWA C-906.
2. Fabricated Fittings: Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock or molded fittings, and tested in accordance with AWWA C-906.
3. Joints: Joints between plain end pipes and fittings shall be made by butt fusion.
4. Unless otherwise shown or required, use thermal butt fusion per ASTM D2657 for plain end pipe and fittings and thermal saddle fusion for saddle branch fittings. Conduct thermal fusion by operators trained and qualified in the recommended procedures of the pipe and fusion equipment supplier.
5. DIPW to HDPE Transitions: Polyethylene assembly consisting of stainless steel, chamfered edge, back-up flange complying with ANSI B16.1 for class 125 pound drilling and a polyethylene pipe flange by stub end. Thermal fuse stub-end to plain pipe. Use stainless steel bolts and nuts and red rubber gaskets.

2.8 GATE VALVES

A. AWWA, Ductile Iron (GVW-2) Gate Valves

1. Nonrising-Stem, Resilient-Seated Gate Valves:

a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.

1) Standard: AWWA C509.
2) Minimum Pressure Rating: 250 psig.
3) Interior Coating: Complying with AWWA C550.
4) Operations: Counterclockwise opening, manual operator.
5) Direct Burial Locations: Mechanical joint ends, o-ring seals, and square operating nut. Where depth of valve is too great for operation by standard wrench, provide suitable, permanently installed valve stem extension and

guide. For each valve, furnish two-piece, cast iron roadway valve box, 5-1/4-inch min. shaft, cast iron top ring, drop type lid with "Stay Put" features, and extensions necessary to adjust to finish grade.

6) All Except Direct Burial Locations: Flanged ends, o-ring seals, position indicators and operating handwheel.

b. Valves under three (3) inch size are not defined by AWWA C509 or C515 but, when required, shall be manufactured to those standards.

c. Use Type 2 gate valves on all installations from two (2) to twelve (12) inches in size,

B. Bronze (GVW-4) Gate Valves

1. Rising Stem, Gate Valves:

a. Description: Bronze body; with solid disc, and threaded ends.

1) Standard: MSS SP-80.
2) Minimum Pressure Rating: 200 psig.
3) Operations: Counterclockwise opening, handwheel operator.

b. Use Type 4 gate valves on exposed piping smaller than two (2) inch diameter.

2.9 BUTTERFLY VALVES

A. AWWA, Iron (BFV-2) Butterfly Valves

1. Description: Cast iron body; mechanical joint connections, rubber seated.

a. Standard: AWWA C504.
b. Minimum Pressure Rating: 150 psig.
c. Actuation: Totally enclosed, oil bath lubricated, gear type reduction, counterclockwise open.

2.10 CHECK VALVES

A. AWWA Check Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
b. McWane, Inc.; M & H Valve Company Div.
c. Mueller Co.; Water Products Div.

2. Description: Iron body, bronze mounted, rubber faced disc, full opening check valves with flanged ends and stainless steel hinge pins.

a. Standard: AWWA C508.
b. Interior Coating: Complying with AWWA C550.
c. Pressure Rating: 175 psig.

2.11 DOUBLE DETECTOR CHECK VALVES (DCVW)

A. Double Detector Check Valves:

1. Description: Iron body, full opening detector check valve with flanged or grooved joint ends and by-pass meter complying with AWWA C510.

a. Standards: UL 312 and FMG approved.
b. Pressure Rating: 175 psig.

2. In addition to detector check valves, furnish gate valve on each side of check valves and on either side of meter.

2.12 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies (TSVW):

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
b. Ford Meter Box Company, Inc.
c. JCM Industries, Inc.
d. Romac Industries, Inc.

2. Description: Sleeve and valve compatible with drilling machine.

a. Standard: MSS SP-60.
b. Tapping Sleeve: Mechanical joint split sleeve and gate valve assembly suitable for working pressures up to 200 psig. Cast- or ductile-iron, two-piece bolted sleeve with recessed flanged outlet for new branch connection.
c. Tapping Sleeve at Contractor's opinion, or due to existing pipe material: Stainless steel tapping sleeve and gate valve assembly complying with AWWA C223 and suitable for working pressures up to 150 psig and testing pressures up to 225 psig. Fabricate sleeve unit, including shell, lugs, nuts, bolts, flange and test plug, from 18-8 stainless steel. Provide sleeve lining gasket and flange gasket of styrene butadiene rubber suitable for potable water service
d. Valve: Furnish gate valve and valve box complying with preceding Gate Valve Type 2 (GVW-2) specifications except provide one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering

"WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.

2.13 PRESSURE REGULATORS

A. Pressure Regulators Type 1 (PR1):

1. Description: All bronze, screwed ends, pressure reducing valve assembly with integral strainer and monel or stainless steel seat, suitable for reducing inlet pressures of up to 300 psig to adjustable reduced pressures between 25 psig and 75 psig.

B. Pressure Regulators Type 2 (PR2):

1. Description: Cast iron body, bronze trimmed, screwed ends, pressure reducing valve assembly of the hydraulic pilot-controlled diaphragm type with resilient disc. Include removable basket type strainer recommended by valve manufacturer. Furnish assembly suitable for reducing inlet pressures up to 300 psig to adjustable reduced pressures between 20 psig and 300 psig.

2.14 FLEXIBLE COUPLING (FCW)

A. Flexible Couplings:

1. Description: Bolted couplings, utilizing plain pipe ends, while permitting angular flexibility without longitudinal restraint of connecting pipe. Fabricate body of welded rolled high strength steel of cylindrical shape with malleable or ductile iron flanges, coupling gaskets of molded synthetic rubber and bolts of corrosion resistant steel alloy.

   a. Standard: AWWA C219.
   b. Interior Coating: Complying with AWWA C550.
   c. Pressure Rating: 150 psig.

2.15 CORPORATION STOP AND CURB STOP

A. Manufacturers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

   a. Mueller Company, Division of Walter Industries, Inc.
   b. Ford Meter Box Company, Inc. (The); Pipe Products Div.

B. Service-Saddle Assemblies: Comply with AWWA C800. Provide assemblies suitable for 200 psig cold water working pressure. Include dual strap saddles and valve compatible with tapping machine.

1. Service Saddles For Ferrous Pipe: Extra heavy, hot dipped galvanized malleable iron bodies with galvanized or cadmium plated double straps and nuts, retained neoprene gasket, and threads mating those of the corporation stop used.

2. Service Saddles For Non-Ferrous Pipe: Heavy cast bronze or waterworks brass body and straps, bronze, brass or stainless steel screws or nuts and bolts, retained O-rings seal, and threads mating those of the corporation stop used.

C. Corporation Stops: Cast brass or bronze with end threads conforming with AWWA C800, and consisting of precision tapered, and individually lapped, key and body surfaces. Shop test each stop for leakproof shutoff at specified working pressure.

D. Curb Stops: Brass or bronze body with resilient plug, permanently non-grease lubricated, and with end connections appropriate to connecting tubing or pipe conforming with AWWA C800. Use stops rated not less than 175 psig working pressure at 180ºF.

2.16 WATER METER BOXES

A. Description: High-density, reinforced plastic body with one piece cast iron lid, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping, unless otherwise approved by the City. Provide box of size and height appropriate to installation of meter and accessories required.

2.17 FIRE HYDRANTS

A. Manufacturers:

1. For standardization of fire hydrants on the City system, furnish one of the following units:

   a. Mueller Company, Centurion Fire Hydrant.
   b. McWane, Inc.; M & H Traffic Model Style 129 Fire Hydrant.
   c. American-Darling Mark 73-2 Fire Hydrant.

B. Dry-Barrel Fire Hydrants:

1. Description: Freestanding, traffic model (“breakable”), compression type, dry barrel 3-way fire hydrant, with one NPS 4-1/2 and two NPS 2-1/2 outlets, shut-off valve 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Furnish cast-iron body, with harnessing lugs for optional reaction bracing, and with 6 inch size inlet connection compatible with connecting pipe. Provide positive shut-off main valve whose minimum orifice diameter is at least 4- 1/4 inches.

   a. Standard: AWWA C502.
   b. Pressure Rating: minimum 150 psig.
   c. Outlet Thread: NFPA 1963 external hose thread for use by local fire department. Include cast-iron caps with steel chains.
   d. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
   e. Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
   f. Exterior Finish: Shop paint above grade portion with silver enamel. Apply one field finish coat of bright silver enamel to hydrant barrel.

g. Installation: Select depth of bury appropriate to actual hydrant installation (forty two (42) inches minimum unless otherwise indicated).
h. Additional: Furnish one (1) operating wrench for each ten (10) hydrants furnished, or fraction thereof.

2.18 WATER METER

A. Water Meters up to 2-inch size are provided by the City upon payment of appropriate fees, deposits, and charges.

B. Water Meters greater than 2-inch:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

a. Neptune Technology Group, Inc.; Utility Management Systems
b. Sensus USA, Inc.; Water Products Div.
c. Muller Systems; Division of Muller Water Products, Inc. (Hersey Meters).
d. Recordall; Badger Meter, Inc.

C. Water meters greater than 2-inch size shall not be supplied by the City, but compliant to the manufacturers listed above.

D. Bypass piping configuration and metering shall be provided for 2-inch and greater water meter configurations compliant with the standards and details of the Gwinnett County Department of Water Resources.

2.19 BACKFLOW PREVENTERS

A. Backflow Preventers (BFP): Reduced pressure type suitable for 150 psig working pressure and complying with ASSE 1013 and AWWA C511 specifications. Use flanged cast iron body with bronze trim. Furnish complete unit including preventer, strainer, and test cocks.

2.20 ACCESSORIES:

A. Pipe Detection Tape:

1. Metal core enclosed 3 inch wide protective plastic jacket which can be readily detected by electronic pipe locator instruments in general use. Provide blue color jacket with block letters reading "Buried Water Line Below".

B. Pipe Tracer Wire:

1. No. 12 AWG solid soft drawn copper having not less than 98 percent conductivity with NEC type THHN, THWN or XHHW insulation jacket. For splices, use direct bury kit DBY/DBR as manufactured by 3M or approved equal.

C. Coarse Granular Material For Pipe Bedding:

1. Crushed stone, crushed gravel, natural gravel, crushed shell, or similar material complying with ASTM C33, and having No. 67 gradation (3/4 inch to No. 4 sieve) or No. 57 (1 inch to No. 4 sieve) gradation.

D. Valve Markers:

1. Concrete post measuring 5 inch square by 4 foot long with edges on top 18 inches chamfered 1/2 inch and 2 inch "V" cast on one face. Concrete is to conform to ASTM C94 having a minimum compressive strength of 3,000 psi at twenty-eight (28) days.

2.21 ANCHORAGE/SUPPORT MATERIALS:

A. Non-direct Burial Locations:

1. Piping Anchorage/Support: Factory fabricated hangers and supports conforming to Manufacturers Standardization Society (MSS) SP-58.
2. Metal Tie Rods, Bands and Accessories: 18-8 stainless steel or other acceptable corrosion resistant components which when combined as a system resist applied thrust at test and working pressures, with suitable allowance for water hammer.

B. Direct Burial Locations:

1. Concrete: Concrete conforming to ASTM C94 having a minimum compressive strength of 2,000 psi at twenty-eight (28) days.
2. Metal Tie Rods, Bands and Accessories: 18-8 stainless steel or other acceptable corrosion resistant components which when combined as a system resist applied thrust at test and working pressures, with suitable allowance for water hammer.

2.22 CONCRETE BLOCKING – THRUST RESTRAINT ON EXISTING COMPONENTS

A. General: Anchorage detailed on Drawings, if any, represents minimum anchorage to be installed. Field conditions may require additional anchorage, and it is the Contractor's responsibility to recognize such additional requirements and to provide appropriate additional anchorage.

B. Provide concrete blocking on existing bends, tees, valves, and other existing components where thrust may develop, except where other exclusive means of thrust restraint are specifically shown on the Drawings.

C. Concrete shall have a compressive strength of not less than 2,000 psi, at twenty-eight (28) days. Provide mix with not less than 5.5 bags of cement per cubic yard and a slump between 3 and 5-inches. For job mixed concrete, submit the concrete mix design for approval by the City. Mix and transport ready mix concrete in accordance with ASTM C 94. Use reinforcing steel conforming to the requirements of ASTM A 615, Grade 60.

D. Provide all pipe, fittings, valves and accessories to be in contact with concrete with polyethylene encasement. Keep joints and hydrant drain openings clear and accessible.

PART 3 - EXECUTION

3.1 GENERAL

A. Drawings are generally schematic, and it is required that the contractor extend and/or modify construction details, as approved by the City, when field conditions necessitate such changes to achieve a safe and properly functioning system.

B. Construct and, if necessary, reconstruct water system work as necessary to obtain system free of breaks or excessive leakage.

C. Unless otherwise indicated, lay and join pipe in trenches and on foundations complying with methods proposed by the pipe manufacturer in writing and approved by the City. Methods will not be approved which are likely to result in lower quality of installation than that afforded by requirements contained in the following articles.

D. Install PVC pipe in accordance with AWWA C605.

E. Install ductile iron pipe in accordance with AWWA C600.

F. Install HDPE pipe in accordance with ASTM D3261, ASTM F1962, and ASTM F2164.

3.2 PIPE FOUNDATION AND LAYING

A. Clean interior of pipe and all joints before laying. When pipe laying activity is not in actual progress, tightly cover open ends of pipe. Avoid permitting dirt, mud, or other material from entering pipe at any time.

B. Avoid damage or shock in handling pipe and accessories. Inspect each length of pipe and reject any defective piece. Carefully protect pipe in place from damage or displacement until backfilling operations are complete.

C. Cut pipe in a manner to avoid damage to pipe or lining, leaving a smooth end at right angles to pipe axis. Smooth and bevel edges of cut pipe for push-on, gasket type joints.

D. Lay pipe at depth dictated by field conditions, but with distance from top of pipe to finished grade not less than forty-two (42) inches unless otherwise shown or specified.

E. Bed pipe on coarse granular material in flat bottom trench with entire pipe barrel bearing uniformly on coarse granular material, except for an approximately eighteen (l8) inch gap at pipe balance point for sling removal. Hand excavate and backfill as required to provide uniform and continuous bearing and support for the pipe. Do not support pipe on hubs or end bells. Consolidate coarse granular material under and around pipe up to pipe centerline by tamping.

F. Join pipe with bells facing direction in which laying operation is progressing. Lay pipe upgrade wherever line grade exceeds ten (10) percent.

G. Control geometric position of pipe to ensure that pipe and fittings accurately conform with grade and alignment requirements. Lay pipe in a straight line or with uniform sweeping

horizontal and vertical curves for proper alignment. Do not exceed manufacturer's recommended maximum joint deflection.

H. Prevent water from accumulating or running in trench during pipe laying operations or before the trench has been backfilled.

I. Adjust pipe depth or alignment to accommodate valve, hydrant or fitting setting, and as necessary to meet tie-in requirements or to avoid obstructions.

3.3 SERVICE TUBING INSTALLATION

A. For water system service connections, an individual water service connection assembly shall be supplied from the public water supply system to serve each individual dwelling unit or structure needing water service on private property, unless otherwise approved by the City. All service connections shall be made in accordance with the requirements stated in this specification.

B. At roads, paved drives, retaining walls, and other paved areas, install service tubing by pushing, pulling, or augering techniques. Do not cut any paved surface without written authorization of the City.

C. At all other locations, install service tubing by trenching and backfilling, unless otherwise noted.

D. Lay tubing at depth dictated by field conditions, but with not less than 18 inches cover.

E. Bed tubing on firm soil. Remove any rocks, masonry, or any other objectionable material which could damage tubing.

F. Lay tubing in compliance with manufacturer's recommendations.

G. Restore ground surface to original condition. Replace or repair any damaged improvements.

3.4 PIPE CONNECTIONS

A. Make all pipe connections with standard factory fabricated fittings except where special connection details (if any) are shown on drawings.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

3.5 INSTALLATION OF WATER PIPE IN TUNNEL LINER

A. Tunnel Liner, 4 Inches and Smaller:

1. Insert water tubing into tunnel liner using methods which prevent damage to tubing.

B. Tunnel Liner, 6 Inches to 42 Inches:

1. Insert water pipe concentrically into tunnel liner by securing hardwood blocks radially or PVC coated steel spacer around water pipe at no more than ten (10) foot longitudinal intervals. Use stainless steel banding or hardware for securing wood blocks or plastic spacers in place.
2. Use water main pipe in tunnel liner with push-on joints or, at the contractor's option, use mechanical joint type provided contractor coordinates actual tunnel liner size to provide at least one (1) inch clearance all around pipe joint gland outside diameter.
3. Restrain pipe and fittings at each end of tunnel liner in accordance with the Paragraph "Anchorage" in this specification section.

C. Tunnel Liner, 48 Inches and Larger:

1. Use the following procedure for installing water pipe in tunnel liner when adequate working room is available; otherwise follow same procedures as specified for tunnel liner, 6 inches to 42 inches.
2. Insert water pipe into tunnel liner after having grouted bottom of tunnel to exact grade required to support pipe in proper position.
3. Permanently secure water pipe in position by blocking each pipe length at top and sides with brick and mortar, followed by bedding water pipe to a depth equal to one-fourth the pipe outside diameter, with concrete.
4. Plug ends of tunnel with twelve (12) inch thickness of masonry, leaving weep holes at lower end of tunnel,

3.6 VALVES, FITTINGS, AND HYDRANTS

A. Provide valves, fire hydrants, fittings and other appurtenances as indicated on the drawings, specified herein, and as requested by the City. Comply with applicable provisions of AWWA C600.

B. Set fire hydrants plumb and with ground line index within one tenth (0.1) foot of actual final ground level. When fire hydrants are adjacent to streets, set pumper connection perpendicular to curb or edge of pavement.

C. Set valves and valve boxes plumb, with valve box cover level with surface. Set lower section of valve box concentric with valve operating stem. Avoid contact at lower end of valve box with valve body or pipe.

D. When valves are installed in areas not subject to vehicular traffic, provide 18 inch square by 4 inch thick concrete pad around top of valve box and a 5 inch square by 4 foot long concrete valve marker. Install valve marker with 18 inches exposed above finished grade and letter "V" facing valve.

3.7 ANCHORAGE INSTALLATION

A. Anchorage, General: Anchorage detailed on drawings, if any, represents minimum anchorage to be installed. Field conditions may require additional anchorage, and it is the contractor's responsibility to recognize such additional requirements and to provide appropriate additional anchorage.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

D. Non-Direct Burial Locations:

1. Place hangers, anchors and other supports as required to prevent excessive sagging or undue strain on joints or equipment. Use factory fabricated hangers only, sized amply for imposed loads.
2. Provide effective anchorage for all pressure piping as necessary to resist thrust caused by unbalanced pressure, giving due allowance for test pressures and water hammer.
3. Install hangers and support in accordance with MSS SP-69 and SP-89.

E. Direct Burial Locations:

1. Anchor all bends, valves, tees, fire hydrants, reducers and other points of unbalanced pressure as necessary to resist thrust at test and working pressures, with suitable allowance for water-hammer. Also anchor piping system installed on steep slopes where gravitational force might otherwise cause piping displacement. Accomplish piping system anchorage by use of concrete reaction bracing, metal tie rods and bands, and/or restrained joint systems. When using concrete reaction bracing, pour concrete against firm earth and allow it to cure for at least five days before placing main under pressure. Position concrete blocks of sufficient size to counteract the magnitude and direction of the resultant thrust force.
2. Accomplish fire hydrant assembly anchorage by use of metal tie rods and bands and/or restrained joint systems. Keep joints and hydrant drain openings clear and accessible. Provide special support blocks at plastic pipes according to manufacturer's recommendation. When using bands and tie rods in conjunction with reaction bracing, provide a separate band for each tie rod. Use corrosion resistant materials throughout. When using restrained joint systems, utilize methods and place these special joints at appropriate fittings and pipe joints in accordance with manufacturer's recommendation.

3.8 SPECIAL CONSTRUCTION

A. Where constructing on piers, supporting pipe on bridges, or for other special work, use safe and generally accepted construction methods to accomplish the required work.

B. When installing water mains across creeks, streams or other drainage channels with flowing water, make installation using directional drilling techniques.

3.9 PIPE DETECTION COMPONENTS

A. Install pipe detection tape in trench, approximately two (2) feet above pipe. Provide pipe detection tape for all non-ferrous water mains unless otherwise directed by the City.

B. Install pipe tracer wire on all non-metallic pipe systems. Tape tracer wire to the top center of the pipe at intervals which prevent wire displacement during backfilling operations. Stub tracer wire up six (6) inches above finished grade at all valves and fire hydrants. Completed tracer wire is to

be electrically continuous between stub-ups. For splices, use direct bury kits. After backfilling is complete, test electrically continuity of each tracer wire segment and provide test results to City.

3.10 LINE CLEANING:

A. Avoid permitting dirt, rubbish, construction materials, etc. to enter lines and appurtenances during construction. Use whatever means are necessary to obtain a clean and internally smooth system prior to final acceptance.

B. Limit use of flushing water to rates and quantities which will not interfere with service to water customers.

3.11 FIELD QUALITY CONTROL

A. General Leakage Requirements:

1. Make entire water line system as near watertight as practicable. Eliminate all detectable leakage regardless of test results hereinafter required.

B. Testing:

1. Furnish and use appropriate test equipment and methods. Include gage, meter, pump and connections.
2. Bleed all air from system prior to testing, providing any necessary corporation stops and piping installations.
3. Pressure test all elements of the piping system. Where piping is buried or otherwise concealed, maintain the pressure test for not less than six hours. Visible piping may be tested for a lesser time period, if approved by the Engineer. Conduct pressure testing at 200 psig unless a lower pressure is recommended by a manufacturer of an element of the system. When a manufacturer does recommend a lower test pressure, furnish the Engineer with a detailed written explanation before commencing test work. In no event may the lower test pressure be less than 110 percent of the nominal working pressure of the pipe comprising the system. Measure pressure for testing referred to the elevational datum of the lowest pipe of the line section being tested.
4. Where possible, use methods and perform construction work in such sequence as necessary to accomplish pressure testing as work progresses. Do not pressure test more than a one mile length of pipe at one time. Provide temporary piping and accessories if required to isolate test sections.
5. Makeup water required to maintain test pressure in gallons per hour per l,000 feet of pipe under test, over the test period may not exceed the quantities shown in the following table:

Pipe Size Inches	Quantity Gal. per Hour	Pipe Size Inches	Quantity Gal. per Hour
2	0.16	16	1.26
3	0.24	18	1.42
4	0.32	20	1.58

Pipe Size Inches	Quantity Gal. per Hour	Pipe Size Inches	Quantity Gal. per Hour
6	0.47	24	1.89
8	0.63	30	2.37
10	0.79	36	2.84
12	0.95	42	3.31
14	1.10	48	3.79

Repair all breaks, detectable leaks or other defects and retest as many times as necessary to obtain passing test.

3.12 DISINFECTING:

A. Chlorinate all potable water lines on completion of construction, after flushing and prior to placing in service. Use precaution to prevent backflow to supply system. Comply with AWWA C651, including Section 9 procedures on final connections to existing mains. At Contractor's option, accomplish chlorination by either the tablet method, continuous feed method or the slug method.

B. Fill lines with potable water containing sufficient chlorine to show a chlorine dose of at best 25 mg/l for the tablet method, a 10 mg/l minimum residual at the end of 24 hours retention period for the continuous feed method, or a 50 mg/l minimum residual at the end of 3 hours of exposure for the slug method.

C. Provide and operate all equipment and provide all materials necessary for disinfecting water mains. Draw off at taps and hydrants along the line until a DPD test or approved chlorine test kit shows a strong indication of residual chlorine.

D. Retain chlorinated water in the system for a period of twenty-four (24) hours for either tablet method or continuous feed method. Test for specified residual. If residual is as specified or greater, flush the system with potable water, otherwise repeat entire procedure until satisfactory results are obtained. If the slug method of disinfection is used, dispose of heavily chlorinated water in a manner acceptable to Federal, state and local environmental regulatory agencies.

E. Demonstrate lines to be free of contamination by drawing samples therefrom on two successive days in the presence of the City. Deliver samples to a qualified laboratory for examination. On receipt of satisfactory test report from the foregoing laboratory, and with the approval of the City, the lines so tested are to be considered free of contamination and placed in service. In the event contamination persists, resterilize as necessary until receipt of satisfactory test report. All costs of disinfecting and bacteriological tests are to be paid by the Contractor.

END OF SECTION 331100

SECTION 333000 - SANITARY SEWER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. City Code, including Development Regulations, Standard Drawings, Zoning Ordinance, Subdivision Regulations, Sewer Use Ordinance, Building Codes and Industrial Pretreatment Program, apply to this Section.

1.2 SUMMARY

A. This Section includes gravity-flow, nonpressure and pressurized force-main sanitary sewers, and appurtenances with the following components:

1. Foundation preparation.
2. Furnishing and laying gravity sewer pipe.
3. Furnishing and laying force-main pipe.
4. Furnishing and/or constructing sewer structures and appurtenances.
5. Cleaning and/or televising constructed work.
6. Testing constructed work.

B. Related sections include the following:

1. Section 311000 “Route Clearing” for topsoil stripping and stockpiling.
2. Section 312000 “Trenching and Backfilling” for excavation and backfilling trenches for utility installation.
3. Section 330523 “Tunneling” for utility line construction.
4. Section 330525 “Directional Drilling” for utility line construction.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene-monomer rubber.

B. PVC: Polyvinyl chloride plastic.

C. PVCFM: Polyvinyl chloride plastic force main pipe.

D. DIP: Ductile iron pipe.

E. DIPFM: Ductile iron pipe force main.

F. HDPE: High density polyethylene pipe.

G. PE: Polyethylene plastic.

1.4 SUBMITTALS

A. Where temporary bypasses by gravity or pumped flow are needed, submit an emergency plan detailing procedures to be followed in the event of pump failures, sewer overflows, service backups, and sewage spillage. Maintain a copy of emergency plan on site for duration of project.

B. Manufacturer's Data: For information only, submit producer's or manufacturer's technical data and installation instructions (where appropriate) for the following products, including laboratory test reports, notarized certifications, or other data as may be required to show compliance with these Specifications, including specified standards:

1. Pipe, fittings and joints.
2. Valves.
3. Manholes and appurtenances.
4. Granular material for pipe bedding.
5. Expansion joints and deflection fittings.

C. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

D. Product Certificates: For pipe and fittings, from manufacturer.

E. Field quality-control test reports.

1.5 DELIVERY, STORAGE, AND HANDLING

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

B. Do not store plastic manholes, pipe, and fittings in direct sunlight. Support pipes from sagging and bending.

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

1.6 PROJECT CONDITIONS

A. Licensing: All work specified in this section, except for sewer system service line installation and sewer line cleaning and televising, is to be performed by a contractor with a valid Utility Contractor’s license issued by the State of Georgia. Sewer service line installation may be performed by either a contractor with a valid Georgia Utility Contractor’s license or by an individual having a valid Master Plumber’s license issued by the State of Georgia.

B. Connection to Existing Pipework and Manholes: Where it is required that connection be made to existing pipework and manholes, expose existing piping and structures and determine the exact fittings and/or other appurtenances necessary to make the connections. Connections to existing pipework indicated on Drawings (if any) are shown only for the purpose of illustrating the general type of connection desired, and no assurance exists that such illustration can be followed precisely.

C. Traffic Control: Schedule and conduct Work in a manner which will minimize inconvenience to vehicular and pedestrian traffic. Provide flaggers, barricades, warning signs, warning lights and other warning means as appropriate. When flaggers are utilized, individuals must meet requirements of Georgia Department of Transportation. Maintain traffic on all roads and streets which must be crossed by trenching by making two separate cuts so that at least one traffic land is open at all times. All traffic controls during construction must conform to Part 6 of the *Manual on Uniform Traffic Control Devices*

D. Weather Limitations: Conduct all operations during weather conditions appropriate to the work being performed.

E. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify City no fewer than seventy-two (72) hours in advance of proposed interruption of service.
2. Do not proceed with interruption of service without City's written permission.

F. Stringing of Pipe: Stringing of pipe along the route and in the rights-of-way shall be limited to pipe that will be installed within the next three workdays. Stockpiling of pipe in the rights-of-way is not permitted.

1.7 QUALITY ASSURANCE

A. Imperfections: Irregardless of tolerances permitted by industry standards specified herein, the City may reject pipe or appurtenances at the manufacturing plant or project site, which have cracks, chips, blisters, lack of smooth interior or exterior surface, evidence of structural weakness, porosity, joint defect, significant variation from theoretical shape, or other imperfection which might, in the opinion of the City, contribute to a reduced functional capability, accelerated deterioration, or reduced structural strength.

B. Repairs: Do not install used, patched, or repaired pipe or appurtenances.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include specified manufacturers or approved equal.

2.2 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS (DIPS)

A. Push-on-Joint Piping:

1. Pipe: ASTM A 746, for push-on joints.
2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
3. Compact Fittings: AWWA C153, ductile iron, for push-on joints.
4. Gaskets: AWWA C111, rubber.
5. Coatings: Cement mortar lining per AWWA C104 with standard asphaltic coating over lining and pipe exterior.

2.3 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS (DIPFM)

A. Push-on-Joint Piping:

1. Pipe: AWWA C151, for push-on joints.
2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
3. Compact Fittings: AWWA C153, for push-on joints.
4. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.

B. Mechanical-Joint Piping:

1. Pipe: AWWA C151, with bolt holes in bell.
2. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
3. Compact Fittings: AWWA C153, with bolt holes in bells.
4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
5. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

2.4 PVC, GRAVITY SEWER PIPE AND FITTINGS (PVC)

A. General: PVC Gravity Sewer Pipe may be used for sewer services of 4 inch and 6 inch size and sewer mains of 8 inch to 15 inch size where depth of cover above pipe is greater than 7 feet under paved surfaces, greater than 4 feet under unpaved surfaces, less than 16 feet total cover, and the installation is within residential zoned properties.

B. Basic specification: ASTM D 3034 type PSM or ASTM D 3033 type PSP PVC bell and spigot sewer pipe with ratio of barrel outside diameter to wall thickness (SDR) no greater than 26.0, with pipe material meeting ASTM D 1784 12454 B or C and pipe stiffness at 5 percent deflection per ASTM D 2412, no less than 46.0 psi.

C. Couplings and adaptors: Provide standard couplings and adaptors specifically designed to connect the PVC pipe to manholes or to other pipe materials. Manhole adaptors must provide a positive bond between the piping system and the mortar or concrete of the manhole structure. Protect all couplings and adaptors by fully encasing in concrete.

D. Joints: ASTM D 3212 elastomeric gasket system comprised of material suitable for use with domestic sewage and conforming to ASTM F 477.

2.5 PVC PRESSURE PIPE AND FITTINGS, FORCE MAIN (PVCFM)

A. PVC Pressure Pipe (For Open Trench Installations): AWWA C900, Class 235, for gasketed joints and using ASTM F 477, elastomeric seals.

1. Fittings NPS 4: PVC pressure fittings complying with AWWA C907, for gasketed joints and using ASTM F 477, elastomeric seals.
2. Fittings NPS 6 and Larger: Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern and using AWWA C111, rubber gaskets.

2.6 HDPE GRAVITY SEWER PIPE AND FITTINGS

A. General: HDPE Gravity Sewer Pipe is to be used for horizontal directional drilling or pipe bursting and inserting applications only after obtaining City approval.

B. Pipe: Manufactured from a pipe resin which meets ASTM D 3350 with a minimum cell classification of 445574C. Manufacture pipe to the dimensions of ASTM F 714, ductile iron pipe size with SDR no greater than 17.

C. Furnish pipe with each section continuously and permanently marked with the following identifying data:

1. Normal size and outside diameter.
2. Material code designation.
3. Dimension ratio number (SDR or DR).
4. Pressure class.
5. ASTM or AWWA specification designation.
6. Manufacturer’s name or trademark and production record code.

D. Fittings: Made from HDPE pipe resin meeting ASTM D 3350 with a minimum cell classification of 445574C.

1. Molded butt fusion fittings shall have a manufacturing standard of ASTM D 3261. Fabricated fittings must have the same pressure rating as the pipe; a DR less than the pipe shall be used. Fabricated fittings are to be manufactured using a Data Logger to record temperature, fusion pressure, and a graphic representation of the fusion cycle shall be part of the Quality Control records.
2. Electrofusion Fittings shall meet the manufacturing standard of ASTM F 1055. Fittings shall have the same pressure rating as the pipe or higher unless otherwise specified on the plans.

E. Installation: See Section 330525 “Directional Drilling” for untrenched (horizontal directional drill) pipe installation methods for HDPE pipe.

2.7 HDPE PRESSURE PIPE AND FITTINGS, FORCE MAINS (HDPE-1)

A. General: HDPE Piping System is to be used for Horizontal Directional Drilling installation of plastic piping which is 4 inch to 16 inch in diameter.

B. High Density Polyethylene Piping System Type DR-9, ductile iron pipe size (DIPS) and conforming to the requirements of AWWA C906 and ASTM F714.

C. Furnish pipe with each section continuously and permanently marked with the following identifying data:

1. Normal size and outside diameter.
2. Material code designation.
3. Dimension ratio number (SDR or DR).
4. Pressure class.
5. ASTM or AWWA specification designation.
6. Manufacturer's name or trademark and production record code.

D. Molded Fittings: HDPE molded fittings shall be manufactured and tested in accordance with ASTM D3261, and tested in accordance with AWWA C-906.

E. Fabricated Fittings: Fabricated fittings shall be made by heat fusion joining specially machined shapes cut from pipe, polyethylene sheet stock or molded fittings, and tested in accordance with AWWA C-906.

F. Joints: Joints between plain end pipes and fittings shall be made by butt fusion.

1. Unless otherwise shown or required, use thermal butt fusion per ASTM D3261 for plain end pipe and fittings and thermal saddle fusion for saddle branch fittings. Conduct thermal fusion by operators trained and qualified in the recommended procedures of the pipe and fusion equipment supplier.

G. DIFM or PVCFM to HDPE Transitions: Assembly consisting of HDPE mechanical joint adapter kit and ductile iron mechanical joint reducer to match HDPE and DIFM or PVCFM pipe sizes. Provide HDPE adapter kit with one (1) butt-fused and one (1) mechanical joint end, rated for 200 PSIG working pressure, with metal insert, metal gland, gasket, bolts and nuts by single manufacturer.

H. Installation: See Section 330525 "Directional Drilling" for untrenched (horizontal directional drill) pipe installation methods for HDPE pipe.

2.8 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

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

C. Nonpressure-Type, Rigid Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

   a. Fernco, Inc.
   b. Or approved equal.

2. Description: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Unshielded, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

   a. Fernco, Inc.
   b. Or approved equal.

2. Description: Elastomeric sleeve with stainless-steel tension band and tightening mechanism on each end.

E. Ring Type, Flexible Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

   a. Fernco, Inc.
   b. Or approved equal.

2. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.9 PRESSURE-TYPE PIPE COUPLINGS

A. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

   a. Cascade Waterworks Mfg.
   b. Ford Meter Box Company, Inc.
   c. JCM Industries.
   d. Romac Industries, Inc.
   e. Smith-Blair, Inc.
   f. Dresser, Inc.
   g. Or approved equal.

2. Reducing or transition, metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-PSIG minimum pressure rating and ends of same sizes as piping to be joined.

    a. Center-Sleeve Material: Stainless Steel.
    b. Gasket Material: Natural or synthetic rubber.
    c. Metal Component Finish: Corrosion-resistant coating or material.

B. Split-Sleeve Couplings: With split sleeve with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.

2.10 WALL PENETRATION PIPE SLEEVE

A. Wall-Penetration Pipe Sleeve Seals (PSS): Modular, mechanical type with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve or opening and provide a water tight seal. Provide insulating glass reinforced pressure plates and stainless steel bolts and nuts. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include the following:

    a. The Metroflex Company.
    b. Linkseal/Thunderline Corporation.
    c. Or approved equal.

2.11 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

    a. EBAA Iron, Inc.
    b. Romac Industries, Inc.
    c. Star Pipe Products.
    d. Or approved equal.

2. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.

2.12 CLEANOUTS

A. Cast Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

    a. The General Engineering Company, Geneco Products

b. Josam Company.
c. MIFAB Manufacturing Inc.
d. Smith, Jay R. Mfg. Co.
e. Wade Div.; Tyler Pipe.
f. Watts Industries, Inc.
g. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

B. PVC Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

a. Canplas Inc.
b. IPS Corporation.
c. NDS Inc.
d. Plastic Oddities, Inc.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Light Commercial Specialty Plumbing Products; Zurn Plumbing Products Group.

2. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.13 MANHOLES

A. Standard Precast Concrete Manholes:

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

a. 48-inch Diameter Manholes: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
b. 60-inch Diameter Manholes: Typical flat-slab-top type, typical for force main Discharge Manholes.

7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.

9. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101 polypropylene, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 36 inches.
10. Adjusting Rings: Interlocking cast iron rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Infra-Riser, rubber composite adjustment ring by EJ Group Inc. or approved equal is acceptable with City approval. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
12. Protective Coating: Plant or field-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint ten (10) mil minimum thickness applied to exterior and/or interior surfaces when indicated.

B. Special Design Precast Concrete Manholes:

1. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
4. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
5. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
6. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101 polypropylene, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 36 inches.
7. Adjusting Rings: Interlocking cast iron rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Infra-Riser, rubber composite adjustment ring by EJ Group Inc. or approved equal is acceptable with City approval. Include sealant recommended by ring manufacturer.
8. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
9. Protective Coating: Plant or field-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint ten (10) mil minimum thickness applied to exterior and/or interior surfaces when indicated.

C. Standard Manhole Frames and Covers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

    a. EJ Group, Inc.; Product No. 41326311 and No. 00133894 respectively.

b. Or approved equal.

2. Description: ASSHTO M306, Ferrous; 24-inch ID by 6-inch riser, with 4-inch-minimum-width flange and 23 ¾-inch diameter cover. Comply with City of Buford Standard Drawing, Sheet No. 1004.

a. Attachment: Attach manhole frame to manhole by adhesive capsule anchor with four (4) stainless steel 7/8” diameter bolts.
b. Lettering: Include indented top design with 1 ¼” sharp face gothic lettering cast into cover, using wording to "CITY OF BUFORD."
c. Material: ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.

D. Bolt Down Manhole Frame and Covers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:

a. EJ Group, Inc.; Product No. 42328176.
b. Or approved equal.

2. Description: ASSHTO M306, Ferrous; 24-inch ID by 5-inch riser, with 3-inch-minimum-width flange and 23 ¾-inch diameter cover. Comply with City of Buford Standard Drawing, Sheet No. 1005.

a. Bolts: Four (4) 5/8” x 2” stainless steel hex with four (4) stainless steel washers and 1/8” thick flat neoprene gasket.
b. Attachment: Attach manhole frame to manhole by adhesive capsule anchor with four (4) stainless steel 7/8” diameter bolts.
c. Lettering: Include indented top design with ½” sharp face gothic lettering cast into cover, using wording to "BUFORD SEWER."
d. Material: ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.
e. Protective Coating: Foundry-applied, coat of asphaltic paint.

E. Drop Connections:

1. Outside Drop Connection: Cast-in-place concrete minimum 2,000 psi, piping of similar materials of sewer line with brick and mortar weir.
2. Inside Drop Connection: Reliner Inside Drop Bowl with stainless steel straps and fasteners; SDR 26 PVC Pipe of same size as influent sewer line.

2.14 CONCRETE

A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 3,000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 3,000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths (¾) of pipe diameter. Form curved channels with smooth, uniform radius and slope.

a. Invert Slope: One tenth (0.1) foot minimum drop through manhole.

2. Benches: Concrete, sloped to drain into channel.

a. Slope: 4 percent.

D. Force Main Discharge Manhole:

1. Field form concrete within the base of manhole to support incoming force main discharge piping, fittings, and outgoing gravity sewer piping without inhibiting sewage flows or resulting in leakage from the manhole.
2. A concrete channel shall be formed to the same width as the connecting gravity sewer pipe, sloping upward from the pipe invert to the force main discharge piping to result in positive drainage to the gravity sewer.
3. Concrete fill shall be formed to promote positive drainage to the gravity sewer channel from any location within the discharge manhole.
4. See Drawing for further discharge manhole details.

E. Ballast and Pipe Supports: Portland cement design mix, 3,000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

2.15 COARSE GRANULAR MATERIAL FOR PIPE BEDDING:

A. Crushed stone, crushed gravel, natural gravel, or crushed shell meeting ASTM D 448, and having No. 67 gradation (¾ inch to No. 4 sieve).

2.16 FINE GRANULAR MATERIAL FOR PIPE BEDDING:

A. Uniformly graded natural or manufactured sand composed of hard, durable particles with 100 percent passing a No. 4 sieve, not more than 25 percent passing a No. 100 sieve, and containing no more than 25 percent total of silt and clay.

2.17 PUMP STATIONS

A. Pump stations, when acceptable to the City, are to conform to the requirements of the *Sanitary Sewer Standards for Pump Stations and Forcemains*, latest edition, by the Gwinnett County Department of Water Resources.

2.18 SEWER LINE CLOSED CIRCUIT TELEVISING (CCTV) EQUIPMENT

A. Use television inspection equipment having an accurate footage counter that displays on a remote monitor the exact distance of the camera from the centerline of the starting manhole. Furnish a remotely operated pan and tilt type camera with optical focus power control from the viewing station. Provide a rotating camera and lighthead configuration with 240 degrees of pan and tilt angle measuring centerline to centerline and 70 degree lens viewing angle.

B. Utilize a color camera providing a minimum of 460 lines of horizontal resolution and 400 lines of vertical resolution. Provide the image pick-up device containing in excess of 379,000 picture elements (pixels). Do not exceed one percent geometrical distortion of the image.

C. Have a tractor drive available to transport the video camera for inspecting dead end sewers and other situations where manhole access at both ends of sewer may not be available.

D. Furnish lighting on video camera suitable to allow proper illumination and a clear video image of the entire periphery of the pipe.

2.19 PIPE DETECTION TAPE AND WIRE:

A. Pipe Tracer Wire: No. 12 AWG solid soft drawn copper having not less than ninety-eight (98) percent conductivity with NEC type THHN, THWN or XHHW insulation jacket. For splices, use direct bury kit DBY/DBR as manufactured by 3M or approved equal.

B. For splices, use direct burial, water and corrosion proof, silicone-filled, pipe detection wire connector kits.

C. Warning Tape: Provide non-metallic warning tape with the words “BURIED SEWER LINE BELOW” or similar phrase printed continuously. Warning tape shall be 3-inch wide, polyethylene material, with printed lettering of black ink on yellow tape, or APWA approved color, and to meet or exceed industry standards.

2.20 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

C. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 Section "Trenching and Backfilling."

3.2 PIPING INSTALLATION

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

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

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

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

E. Unless otherwise indicated, lay and join pipe in trenches and on foundations complying with methods proposed by the pipe manufacturer in writing and approved by the City. Methods will not be approved which are likely to result in lower quality of installation than that afforded by requirements contained in the following articles.

F. Install service wyes at points indicated, herein specified or as requested by the City. If service wyes are not connected to a building service under this Work, close end of pipe with removable factory fabricated plug or stopper. Provide cleanouts in services at not more than 75-foot intervals and where pipe horizontal deflection exceeds 45 degrees.

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

H. Provide complete piping systems including pipe, fittings, adapters, valves, sleeves, jointing, gaskets, caulking, hangers, supports, blocking, inserts, and other components necessary for safe and properly functioning use.

I. Construct and if necessary reconstruct all piping systems as necessary to obtain systems free of breaks, detectable leakage and other defects.

J. Install piping at indicated slopes; free of sags and bends.

K. Cut pipe in a manner to avoid damage to pipe or lining, leaving a smooth end at right angles to pipe axis.

L. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install service piping pitched down in direction of flow, at minimum slope of two percent and with a minimum cover of 30-inches, unless otherwise indicated.
2. Install piping with 36-inch minimum cover. Where cover depth less than 36-inches is indicated or unavoidable, contact City for direction.
3. Install ductile-iron and special fittings according to AWWA C600 and as herein specified.
4. Install PVC gravity sewer service piping according to ASTM D 2321 and ASTM F 1668.
5. Install HDPE , gravity sewer piping in according to ASTM F 1962.
6. Install pipe tracer wire on all non-metallic gravity-flow, nonpressure, drainage piping.

M. Install force-main, pressure piping according to the following:

1. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
2. Install piping with 36-inch minimum cover.
3. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
4. Install PVC pressure piping according AWWA 605 or ASTM D 2774 and ASTM F 1668.
5. Install HDPE , pressure piping in according to ASTM F 1962.
6. Install pipe tracer wire on all non-metallic force mains.

3.3 PIPING APPLICATIONS

A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.

a. Unshielded flexible couplings for same or minor difference OD pipes.
b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure-type pipe couplings for force-main joints.

3.4 PIPE JOINT CONSTRUCTION

A. Make all pipe connections with standard factory fabricated fittings except where special connection details (if any) are shown on Drawings.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

D. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

E. Join gravity-flow, nonpressure, drainage piping according to the following:

1. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
2. Join ductile-iron and special fittings according to AWWA C600 or AWWA M41.
3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
4. Join PVC gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
5. Join HDPE gravity sewer piping according to ASTM D 3261.
6. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

F. Join force-main, pressure piping according to the following:

1. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
2. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
3. Join PVC pressure piping according to AWWA C605 or AWWA M23 for gasketed joints.
4. Join HDPE pressure piping, for horizontal directional drilling applications, by field installed butt-fused joints per ASTM D 3261.
5. Join dissimilar pipe materials with pressure-type couplings.

3.5 PIPE FOUNDATION:

A. Definition of Pipe Foundation Terms:

1. Trench depth is the vertical distance from pipe invert or flow line to finished ground surface.
2. Trench width is the horizontal distance between trench walls at any point from one foot above top of pipe to trench bottom.

3.6 DUCTILE IRON PIPE EMBEDMENT:

A. Ductile Iron Pipe Bedding: Use ductile iron pipe bedding embedment of the following laying condition type in compliance with ANSI/AWWA C600.

1. Type 5 consists of the following construction method: Bed pipe in carefully placed compacted coarse granular material placed on a flat trench bottom. Thickness of granular bedding must be at least one-eighth the outside pipe diameter, but not less than 4 inches thick under pipe barrel, and extend at least halfway up the pipe barrel at the sides. Spade and shovel-slice embedment material to fill and support pipe haunch area. Place compacted select backfill material or coarse granular material above the coarse granular

material up to the top of the pipe. Select backfill material is native soil excavated from the trench that is free of foreign material, frozen earth, organic material, and large stones. Achieve compaction not less than 90% of maximum dry density per ASTM D698 (Standard Proctor) for all material.

2. Type 4 consists of the following construction method: Bed pipe in carefully placed compacted coarse or fine granular material placed on a flat trench bottom. Thickness of granular bedding must be at least one-eighth the outside pipe diameter, but not less than 4 inches thick under pipe barrel, and extend at least one-sixth of the outside diameter up the pipe barrel haunches at the sides. Spade and shovel-slice embedment material to fill and support pipe haunch area. Place compacted select backfill material or coarse granular material above the granular material up to the top of the pipe. Select backfill material is native soil excavated from the trench that is free of foreign material, frozen earth, organic material, and large stones. Achieve compaction not less than 80% of maximum dry density per ASTM D698 (Standard Proctor) for all material.
3. Type 2 consist of the following construction method: Bed pipe on a flat trench bottom with select backfill lightly consolidated to centerline of pipe. Spade and shovel-slice backfill material to fill and support pipe haunch area. Select backfill material is native soil excavated from the trench that is free of foreign material, frozen earth, organic material, and large stones.

B. Unless otherwise indicated, lay pipe in trenches and embedments prepared as selected by the Contractor in conformance with the pressure class, laying condition type, trench depth, and pipe size tabulated below. Provide trench width sufficient to place and compact embedment material, but not less than nominal pipe diameter plus 2-feet. If trench width at top of pipe is greater than six (6) pipe diameters, compact embedment material below the pipe springline for a distance at least 2.5 pipe diameters each side of pipe for 10- inch size pipe or less and at least one (1) pipe diameter or 2- feet (whichever is greater) each side of pipe for 12- inch size pipe and larger.

	Maximum Trench Depth in Feet				
	Type 5 Laying Condition				
Pipe	Pressure	Pressure	Pressure	Pressure	Pressure
Size	Class	Class	Class	Class	Class
Inches	150	200	250	300	350
4 thru 8	--	--	--	--	51.6
10	--	--	--	--	46.2
12	--	--	--	--	46.0
14	--	--	37.6	43.4	45.9
16	--	--	35.7	40.5	46.0
18	--	--	32.7	38.4	43.0
20	--	--	32.0	36.9	40.7
24	--	27.2	31.2	34.9	39.4
30	24.7	26.9	29.8	32.4	36.6
36	24.7	26.4	29.1	31.8	35.9

	Maximum Trench Depth in Feet				
	Type 4 Laying Condition				
Pipe	Pressure	Pressure	Pressure	Pressure	Pressure
Size	Class	Class	Class	Class	Class
Inches	150	200	250	300	350
4 thru 6	--	--	--	--	48.4
8	--	--	--	--	35.1
10	--	--	--	--	29.5
12	--	--	--	--	29.2
14	--	--	25.0	27.7	29.1
16	--	--	25.5	27.8	30.2
18	--	--	24.5	28.0	30.1
20	--	--	23.9	28.1	30.0
24	--	19.6	23.1	26.5	30.5
30	17.4	19.4	22.0	24.3	28.1
36	17.4	19.0	21.4	23.8	27.5

	Maximum Trench Depth in Feet				
	Type 2 Laying Condition				
Pipe	Pressure	Pressure	Pressure	Pressure	Pressure
Size	Class	Class	Class	Class	Class
Inches	150	200	250	300	350
4 thru 6	--	--	--	--	32.3
8	--	--	--	--	21.4
10	--	--	--	--	16.4
12	--	--	--	--	16.0
14	--	--	12.0	14.8	16.1
16	--	--	12.2	14.9	16.8
18	--	--	12.6	15.0	17.0
20	--	--	12.8	15.1	17.3
24	--	10.1	13.3	15.3	17.6
30	--	11.2	13.7	15.4	17.8
36	--	11.3	14.1	16.0	18.4

3.7 THERMOPLASTIC (PVC) PIPE EMBEDMENT

A. Unless otherwise indicated, lay pipe in trenches and embedments complying with ASTM D2321 and the following requirements. Bed pipe in carefully placed and compacted Class IB, II, or III flexible pipe bedding materials placed on a stable flat trench bottom and under the pipe haunches. Thickness of flexible pipe bedding must be at least one-eighth the outside pipe diameter, but not less than 4 inches thick under pipe barrel, and extend at least halfway up the pipe barrel at the sides. Spade and shovel-slice embedment material to fill and support pipe haunch area. Achieve compaction not less than 85% of maximum dry density per ASTM D698 (Standard Proctor) for all bedding and haunching material. Place initial backfill of compacted

Class IB, II, or III flexible pipe bedding material to a minimum depth of 6 inches over the top of pipe. Achieve compaction not less than 85% of maximum dry density per ASTM D698 (Standard Proctor) for all Class IB and II initial backfill material and not less than 90% of maximum dry density per ASTM D698 (Standard Proctor) for all Class III initial backfill material. Use only Class IA or IVA flexible pipe bedding materials where authorized by the Engineer. Do not use Class IVB or V flexible pipe bedding materials for pipe embedment under any circumstances.

B. Provide trench width sufficient to place and compact embedment material, but not less than the values tabulated below. If trench width at top of pipe is greater than six pipe diameters, compact embedment material below the pipe springline for a distance at least 2.5 pipe diameters each side of pipe for 10 inch size pipe or less and at least one pipe diameter or two feet (whichever is greater) each side of pipe for 12 inch size pipe and larger.

Pipe Size, In.	Minimum Trench Width, Ft.-In.
4	1-10
6	2-0
8	2-2
10	2-4
12	2-6
15	2-9
18	3-0
24	3-9
30	4-4

3.8 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated. Set units plumb to exact grade on a minimum of 3- inches of compacted coarse or fine granular pipe bedding material.

B. Install precast concrete manhole sections with sealants according to ASTM C 891. Use materials and construction techniques necessary to achieve permanent watertight joints and connections.

C. Form continuous concrete channels and benches between inlets and outlet. Shape inverts and channels neatly for smooth hydraulic flow.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Make frames, subject to traffic, firm and stable under actual traffic conditions. Set tops not in pavements as indicated on Drawings or directed by the City.

E. Install a drop connection in manhole for all pipes with an influent invert of 2-foot or greater elevation difference from discharge invert. Comply with City of Buford Standard Drawing, Sheet No. 1001 for installation. For influent sewer lines 12-inch and less, install at Contractor's opinion outside or inside drop connection. For influent sewer lines greater than 12-inch, install outside drop connection only.

3.9 ADJUSTMENT TO EXISTING MANHOLE

A. General: Where indicated on the Drawings or instructed by City, adjust existing manhole frame and cover to grade by adjustment ring, grade ring, or riser sections.

3.10 PUMP STATION INSTALLATION

A. Pump stations, when acceptable to the City, are to be installed in accordance with the requirements of the *Sanitary Sewer Standards for Pump Stations and Forcemains*, latest edition, by the Gwinnett County Department of Water Resources.

3.11 CONCRETE PLACEMENT

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

3.12 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use ductile iron pipe or PVC pipe and similar fittings in sewer service lines at branches for cleanouts and riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use light-duty, top-loading classification cleanouts in unpaved foot-traffic areas.
2. Use medium-duty, top-loading classification cleanouts in paved foot-traffic (sidewalk) areas.
3. Use heavy-duty, top-loading classification cleanouts in vehicle-traffic service areas.
4. Use extra-heavy-duty, top-loading classification cleanouts in roads.

B. Provide cleanout frames and covers set in earth in cast-in-place or precast-concrete block, 12-inch by 12-inch by 4-inch deep. Set with cleanout tops one half (½) inch above surrounding grade.

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

3.13 CONNECTIONS

A. Make all pipe connections with standard fittings, manholes, structures, or special construction detail on Drawings. Locate building service lines and connect thereto with standard fittings.

B. At manholes and other structures, neatly cut all connecting piping flush with inside surface, and provide flexible pipe joint within 18- inches of outer surface. Provide PSS pipe sleeve around opening. If necessary, use supplemental materials and techniques to obtain a watertight connection.

C. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping with nonpressure-type coupling.

2. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
3. When field pipe connections to existing manholes are required, core necessary holes sized to install new pipe and allow watertight seal with use of non-shrink grout, rubberized boot, or other acceptable materials and/or systems. Replace any existing manhole units excessively damaged by connection operations.

3.14 CLOSING ABANDONED SANITARY SEWER SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

1. Close open ends of piping with at least 8- inch thick, concrete and/or brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:

1. Remove and salvage frame and cover.
2. Abandon all sewers connecting to manhole and seal openings with at least 8-inch thick, concrete and/or brick masonry bulkheads.
3. Remove top of manhole down to at least 36-inches below final grade.
4. Cut minimum of two (2) openings in manhole bottom 6-inches in diameter for groundwater passage.
5. Fill remaining manhole structure to grade as follows:
    a. Manholes Under Pavement: Fill manhole with coarse granular material. Patch pavement in accordance with the appropriate pavement patch detail.
    b. Fill manhole with stone, rubble, gravel, and compacted earth. Restore surface as required by the specifications.

C. Backfill to grade according to Section 312000 "Trenching and Backfilling."

3.15 SPECIAL CONSTRUCTION

A. Where constructing on piers, supporting pipe on bridges, or for other special work, use safe and generally accepted construction methods to accomplish the required work.

B. When installing force mains across creeks, streams or other drainage channels with flowing water, make installation using directional drilling techniques.

3.16 INSTALLING SANITARY SEWER IN TUNNEL LINER

A. Tunnel Liner, 6 Inches to 36 Inches:

1. Insert sewer pipe concentrically into tunnel liner by securing treated hardwood skids or casing spacers radially around sewer pipe at no more than l0 foot longitudinal intervals. Use steel banding for securing skids in place. Size skids or spacers to prevent contact between pipe bells and tunnel liner.

B. Tunnel Liner, 42 Inches and Larger:

1. Use the following procedure for installing sewer pipe in tunnel when adequate working room is available, otherwise follow same procedures as specified for tunnel liner, 6 inches to 36 inches.
2. Insert sewer pipe into tunnel liner after having grouted bottom of tunnel to exact grade required to support pipe in proper position.
3. Permanently secure sewer pipe in position by blocking each pipe length at top and sides with brick and mortar or casing spacers, followed by bedding sewer pipe to a depth equal to one-fourth the pipe outside diameter, with concrete.
4. Plug ends of tunnel with 12 inch thickness of masonry, leaving weep holes at lower end of tunnel.

3.17 ANCHORAGE

A. General: Anchorage detailed on Drawings, if any, represents minimum anchorage to be installed for pressure piping. Field conditions may require additional anchorage, and it is the Contractor's responsibility to recognize such additional requirements and to provide appropriate additional anchorage.

B. Direct Burial Locations:

1. Anchor all bends, valves, tees, reducers and other points of unbalanced pressure as necessary to resist thrust at test and working pressures, with suitable allowance for water-hammer. Also anchor piping system installed on steep slopes where gravitational force might otherwise cause piping displacement. Accomplish piping system anchorage by use of concrete reaction bracing, metal tie rods and bands, and/or restrained joint systems of 18-8 stainless steel or other acceptable corrosion resistant components. When using concrete reaction bracing, pour concrete against firm earth and allow it to cure for at least five days before placing main under pressure. Provide concrete conforming to ASTM C94 having a minimum compressive strength of 2,000 psi (13.8 MPa) at 28 days. Position concrete blocks of sufficient size to counteract the magnitude and direction of the resultant thrust force as shown on the Drawings and in such a way that the pipe and fitting joints will be accessible for repair.
2. Provide special support blocks at plastic pipes according to manufacturer's recommendation. When using bands and tie rods in conjunction with reaction bracing, provide a separate band for each tie rod. Use corrosion resistant materials throughout. When using restrained joint systems, utilize methods and place these special joints at appropriate fittings and pipe joints in accordance with manufacturer's recommendation.

3.18 PAINTING

A. Clean and prepare concrete manhole surfaces for field painting. Remove loose efflorescence, chalk, dust, grease, oils, and release agents. Paint the following concrete surfaces as recommended by paint manufacturer:

1. Precast Concrete Manholes: All exposed exterior and/or interior as indicated.

3.19 IDENTIFICATION

A. Materials and their installation are specified in Section 312000 "Trenching and Backfilling." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.

1. Use warning tape over ferrous piping.
2. Use pipe detection wire over nonferrous piping and over edges of underground manholes.

B. Install continuous non-metallic warning tape in trench, approximately 12-inches below finish grade. Provide non-metallic warning tape for all pipe and tubing installed by open-cut methods.

C. Install pipe tracer wire on all non-metallic pipe systems. Tape tracer wire to the top center of the pipe at intervals which prevent wire displacement during backfilling operations. Stub tracer wire up six (6) inches above finished grade at all manholes and force main valves with at least 24 inches of coiled wire. Completed tracer wire is to be electrically continuous between stub-ups. For splices, use direct bury kits. After backfilling is complete, test electrically continuity of each tracer wire segment and provide test results to City.

3.20 SEWER LINE CLOSED CIRCUIT TELEVISING INSPECTION (CCTV)

A. Inspection of interior of piping via closed circuit televising (CCTV) is required for acceptance prior to placing sewer line in service. Permanently correct all sags, pipe material defects, joint defects, and any other identified defects determined by CCTV inspection and repeat operations until approved by City Inspector.

B. When flow in a sewer line is plugged, blocked, or bypassed, protect the sewer lines from damage that might result from sewer surcharging. Ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved.

C. Do not exceed a video inspection traverse rate of 30 feet per minute so that sewer line can later be thoroughly examined by the City while viewing video recording. The video recording will include on-screen observation identifications that label continuous footages, defects, pipe diameter, direction of flow, direction of viewing, manhole and street reference locations.

D. Make a color video recording on CD or DVD ROM of all sewers inspected and also provide a paper report generated by the video inspection software. Ensure inspection reports and videos are compatible with Microsoft Windows software. Index inspection videos on CD or DVD ROM to allow for faster viewing by the City. Video files must be formatted in mpeg, mpegII or mpeg4. Record video in a non-proprietary video format to allow for playback on any PC

computer and/or DVD player. A computer, integrated with the video inspection equipment, will be used to eliminate errors from separate processes.

E. Describe all defects and observations with a standard table of descriptions so that there is no variation caused by operator subjectivity. Provide a printed legend of defect classifications that identifies a color-coded rating system for defect observations and their severity. Attach the legend of defect classifications to each and every written report for easy evaluation. Record and rate the severity of each defect or observation according to the legend of classification published by the Contractor.

F. Deliver one digital copy of report and video and one paper copy of report to the City.

3.21 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

1. Submit separate report for each system inspection.
2. Defects requiring correction include the following:

    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of the City.
3. Schedule tests and inspections by City with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig. While maintaining test pressure, make a careful and systematic search for leaks. When rate of makeup water exceeds that which can reasonably be accounted for by observed leaks, continue the test period as necessary to locate the additional leaks. Eliminate leaks found and retest. Repeat the procedure until all detectable leaks have been eliminated and the piping system is as near watertight as practical.

    a. Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
    b. PVC Piping: Test according to AWWA C605, "Hydraulic Testing" Section.

c. HDPE Piping: Test according to ASTM F 2164.

C. Leaks and loss in test pressure constitute defects that must be repaired. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

D. Air Testing:

1. Nominal 4 Inch to 24 Inch Pipe: After completing backfill of a sewer line section, conduct a low pressure air test depending on pipe material in accordance with ASTM C 924, ASTM C 828, ASTM F 1417, or UNI-B-6 guidelines for installation acceptance. Perform such tests using the following general procedures:

   a. Temporarily plug line segment between two (2) manholes using plugs having air tight fittings through which low pressure air can be introduced into the pipe segment being tested.
   b. Introduce low pressure air into the test pipe segment until the internal air pressure reaches 4.0 psig above ground water pressure, if any.
   c. Wait at least two (2) minutes for air temperature in the test segment to stabilize while internal air pressure remains no less than 3.5 psig above ground water pressure.
   d. Accurately determine the elapsed time for internal pressure to drop 1.0 psig.

2. The air test is acceptable if elapsed time for an internal pressure drop of 1.0 psig is no less than shown in the following tables:

   a. For Thermoplastic or Ductile Iron Sewer Lines:

Pipe Diameter (inches)	Minimum Time (min:sec)	Maximum Length for Minimum Time (ft)	Minimum Time for Longer Length (sec) L = Total Length
4	3:46	597	.380 L
6	5:40	398	.854 L
8	7:34	298	1.520 L
10	9:26	239	2.374 L
12	11:20	199	3.218 L
15	14:10	159	5.342 L
18	17:00	133	7.692 L
20	19:50	114	10.470 L
24	22:40	99	13.674 L

3. Nominal 27 Inch and Larger Pipe: After completing backfill of a sewer line section, conduct a low pressure air test on each pipe joint in the section in accordance with ASTM C 1103 for concrete pipe sewer lines or by using methods and devices acceptable to the Engineer. Perform such tests using the following general procedures:

   a. Properly position and completely secure test unit over pipe joint being tested.
   b. Introduce low pressure air into the pipe joint test area until the internal air pressure reaches 3.5 psig above ground water pressure, if any.

c. The joint air test is acceptable if the internal pressure drops less than 2 psi in 10 seconds.

4. At each manhole constructed where ground water is known to exist, install a small diameter pipe nipple through the manhole wall at the time that the sewer pipe is installed. Locate the nipple immediately above the lowest connecting sewer pipe, and grout the nipple in place concurrently with grouting the sewer pipe. Prior to placing the nipple, wrap it with a continuous length of heavy nylon chord which can be pulled out, thus permitting removal of the nipple after test work is complete. Just before commencing the air test, attach a clear plastic tube to the nipple, and hold the tube end vertically upward. After ground water has stopped rising in the plastic tube, measure the vertical distance from water level to pipe invert in feet. Average this distance observed at manholes on each end of the test segment, and divide the average distance in feet by 2.3 to obtain the ground water pressure to be used in computing required test air pressure.
5. Permanently correct excessive leakage determined by air testing, and repeat operations until City Inspector witnesses a successful test on each line segment or joint; then remove nipple through manhole wall without disturbing adjacent grout. Permanently caulk resulting hole watertight.

E. Deflection Testing:

1. Conduct internal deflection testing on all installed PVC gravity sewer lines 6-inch size and larger, no sooner than 30 days after completion of trench backfilling and after pipeline is completely cleaned and flushed. Deflection testing consists of pulling an approved solid pointed mandrel through the completed pipeline from manhole to manhole without using mechanical pulling devices. Mandrel testing is successful when the mandrel device can be pulled through the pipe between manholes in a continuous operation, without interruption. Repair or replace all defective pipe found during mandrel testing and conduct another deflection test to determine the extent and necessary repair of any additional deficiencies. After repairing all defects, perform successful mandrel testing no less than 30 days after completion of trench backfilling in the presence of the City.
2. Use a rigid, non-adjustable mandrel with odd number of legs or runners (not less than nine legs) and a length at least 75% of the inside diameter of the pipe being tested. Furnish mandrels sized as tabulated below using base inside diameters complying with ASTM D3034 and F679: table:

5 PERCENT DEFLECTION MANDREL (ASTM D 2412)			
Nominal Size, In	Mandrel O.D., In	Tolerance In	Nearest 1/16”
6	5.45	0.01	5-7/16
8	7.28	0.01	7-4/16
10	9.08	0.01	9-1/16
12	10.79	0.01	10-13/16
15	13.20	0.01	13-3/16

3. Upon request by the City, certify the accuracy of the mandrel test gauges by sliding proving rings to an accuracy of 0.05 inches over the mandrel. Use proving rings complying with ASTM F679 and ASTM D3034.

F. Manhole Testing: Perform manhole vacuum testing on gravity sewer and force main discharge manholes as follows:

1. Plug all lift holes with non-shrink grout.
2. Temporarily plug all pipes entering the manhole and securely brace each plug to prevent them from being pulled into the manhole.
3. Place the vacuum test head at the top of the manhole in accordance with the testing equipment manufacturer's recommendations.
4. Draw a vacuum of 10-inches of mercury on the manhole and close the valve on the testing equipment vacuum line and shut off the vacuum pump. Measure the time for the vacuum to drop to 9- inches of mercury.
5. The manhole test passes if the time for the vacuum reading to drop from 10-inches of mercury to 9-inches of mercury meets or exceeds the values indicated in the following table:

Depth (feet)	Time in Seconds per Indicated Manhole Diameter		
	48" Dia.	60" Dia.	72" Dia.
0-8	20	26	33
8-10	25	33	41
10-12	30	39	49
12-14	35	46	57
14-16	40	52	67
16-18	45	59	73
18-20	50	65	81
20-22	55	72	89

6. If the manhole fails test, permanently correct excessive leakage determined by manhole vacuum testing and repeat vacuum test until a successful test is achieved.
7. Leaks and loss in test pressure constitute defects that must be repaired.
8. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

G. Provide temporary piping ends, blind flanges, blocking test pumps, and other work necessary to safely and effectively perform hydrostatic testing.

H. Remove or otherwise protect all pipe connected elements which might be damaged by hydrostatic testing. Provide temporary pipe ends as necessary to avoid extending hydrostatic testing into any electrical or control panel.

I. Prepare reports of testing activities.

3.22 CLEANING

A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

B. Avoid permitting dirt, rubbish, construction materials, etc. to enter lines and appurtenances during construction. Use whatever means are necessary to obtain a clean and internally smooth system prior to final acceptance.

C. Clean and flush existing force mains and gravity sewers to be abandoned as follows:

1. Purge existing force mains and gravity sewers to be abandoned initially, with potable water before abandoning and disconnecting. Provide bypass pumping operations as necessary.

    a. Purge line with enough water to remove any remaining sanitary sewerage waste and debris from line, to the pump station or storage ponds, without surcharging the pump station or storage areas. Utilize vacuum trucks as necessary to remove excess fluid, grit, and grease that cannot be drained.

END OF SECTION 333000