

SECTION 02400  
TUNNELING

PART 1 - GENERAL

1.1 SCOPE OF WORK

The work includes furnishing all material, labor, tools, equipment, skills, and incidentals necessary to install a tunnel and tunnel liner below grade.

1.2 DEFINITIONS

Tunneling is defined as horizontal excavation permanently supported with tunnel liners installed by either a guided operation in which a tunnel boring machine is propelled by grippers that react off tunnel sidewalls, tunnel liner or by hand excavation.

1.3 METHOD OF CONSTRUCTION

Anticipated soil conditions for the tunnel construction vary from soil, weathered rock, to rock. The method of construction will be a hand mined operation in which workers work inside of the previously placed tunnel liner and excavate for and place the new liner one course at a time. The minimum size of tunnel and tunnel liner shall be as shown on contract drawings. The Contractor may propose a larger tunnel and tunnel liner; such proposal is subject to acceptance by the Owner. The Contractor bears all risk in regards to obtaining this acceptance and bears all costs in regards to the larger tunnel and tunnel liner.

All construction will occur within Georgia Department of Transportation (GDOT) right of way. Contractor's means and methods will be subject to GDOT approval and must comply with GDOT Specifications. Rock blasting by the Contractor is subject to GDOT permitting. The Contractor is responsible for obtaining GDOT permits and bears all risk in regards to obtaining this approval.

1.4 ORDER OF WORK

The Engineer will designate the beginning and ending points, and elevations for installation of casing.

1.5 QUALIFICATIONS

1. Contractor:

- a. Shall have sufficient tunneling experience to perform the Work by having performed a minimum of 3 previous tunneling projects of similar size and scope.

- b. Shall have sufficient tunneling experience to perform the Work by having performed a minimum of 1 of the 3 previous tunneling projects in a similar geological rock formation with a similar length of rock tunneling.
- c. .
- 2. Contractor Personnel:
  - a. Project Manager: Minimum of five years recent experience managing projects of similar size and complexity and containing the same elements as required by this project.
  - b. Field Superintendent: Minimum experience of two recent projects working with the same equipment and systems required for this project.
  - c. .
  - d. Safety Representative: Minimum of five years recent experience in tunnel and pipe jacking operations. OSHA certified.
- 3. Contractor's Engineer:
  - a. Shall have provided engineering services on a minimum of 3 previous tunneling projects within Georgia.
- 4. Tunnel Liner manufacturer:
  - a. Manufactured tunnel liner for a minimum of 5 years.
  - b. Provided tunnel liner for a minimum of 3 tunneling projects similar in size and scope.

## 1.6 SUBMITTALS

Submit the following:

- 1. Qualifications of Contractor.
  - a. Cover sheet with date, company name, address, telephone and fax numbers, email address, and contact person.
  - b. Resumes of managerial, supervisory and operational key personnel:
  - c. Project Experience containing the following information:
    - 1) Date, full name of project, and location.
    - 2) Owner's name, address, telephone and fax numbers, email address, and contact person.
    - 3) Client's name, address, telephone and fax numbers, email address, and contact person.
    - 4) Employees in charge of work at both head office and site.
    - 5) Description of relevant work successfully completed, including ground conditions.
    - 6) Features under which pipe passed, depth below the water table, photos, and published articles if available.
    - 7) Additional information as necessary.
- 2. Contractor's Means and Methods.

Describe procedures and resources that will be employed to carry out work including method and sequence.

  - a. Describe the methods of tunnel construction for the length of the project;

- identifying sections of differing methods.
- b. Describe the method of installing tunnel liner and grouting behind tunnel liner.
- c. Describe the means and methods of maintaining line and grade, and reestablishment of line and grade as required.
- e. Describe the placement of grout filler at bottom of tunnel liners to support carrier pipe on casing spacers.
- f. Describe the installation of carrier pipe, pipe jointing, and testing.

3. Materials.

Submit full details of all materials incorporated into the construction.

4. Settlement Monitoring Plan.

- a. Submit Surveying and Monitoring plan for review before construction. Identify location of settlement monitoring points, reference benchmarks, survey schedules and procedures, and reporting formats.
- b. Submit Building and Structures Assessment Plan for review after construction.
  - 1) Furnish pre-construction and post-construction assessment for building, structures, and pavement located within distance of 200 feet from centerline of proposed tunnel, and jacking and receiving pits.
  - 2) Include photographs or video of existing damage to structures near alignment.

5. Safety Plan.

- a. Provide a Safety Plan complying with all project and jurisdictional requirements and referenced standards. No tunneling shall be permitted without a reviewed Safety Plan.
- b. The safety plan shall include but not be limited to:
  - 1) Review of all safety requirements.
  - 2) Specification of all safety equipment required and maintenance routines for all equipment.
  - 3) Specification of all personal protection equipment.
  - 4) Specification of all personal training requirements for each employee.
  - 5) Specification of safety procedures including evacuation and re-entry procedures.

6. Tunnel Design by Georgia Professional Engineer.

- a. Contractor shall employ the services of a Georgia Professional Engineer experienced in tunneling to design tunnel liner, to design vertical shafts for tunnel entrances, and to review the Contractor's means and methods of construction.
- b. The Georgia Professional Engineer shall:
  - 1) Design the tunnel liner in accordance with GDOT Specification

Section 555 – Tunnel Liner and other appropriate codes. The Contractor shall bare the cost of all material, labor, and other costs.

a) The design shall be performed for two conditions.

- 1) Construction
  - 2) Final structural load with 75 year service life.
- 2) Design for the vertical shafts at the tunnel entrances. Design any thrust blocking required for the tunnel machine. The Contractor shall bare the cost of all vertical shafts necessary for the tunnel entrances including material, labor, and all other costs.
  - 3) Review all grout and concrete designs.
  - 4) Certify the Contractor's means and methods.
  - 5) Provide all calculations signed and sealed.

## 1.7 PROJECT REQUIREMENTS

1. Perform tunneling so as not to interfere with, interrupt or endanger surface and activity thereon, and minimize subsidence of surface, structures, and utilities above and near tunnel.
2. Repair and restore damaged property from tunnel operation settlement to its original condition before being disturbed at no cost.
3. Cooperate with the Engineer in record surveying.
4. Follow applicable ordinances, codes, statutes, rules, and regulations of State of Georgia, applicable County building codes, affected Railroad Company, and applicable regulations of Federal Government, OSHA 29CFR 1926, and applicable criteria of ANSI A10.16-1995 (R2001), "Safety Requirements for Tunnels, Shafts, and Caissons."

## PART 2 - PRODUCTS

### 2.1 GENERAL

The Contractor shall furnish all materials and incidental items (whether or not they are specifically described herein) necessary to complete all work called for under the contract. The materials stated as follows are minimum requirements; if necessary, the Contractor will provide higher strength materials or alternate materials as determined by the calculations of the Georgia Professional Engineer.

### 2.2 MATERIALS

#### A. Tunnel Liner.

In accordance with GDOT Specification Section 555 – Tunnel Liner, and as follows:

Tunnel shall be of the diameter as required and thickness determined by Contractor's Engineer and reviewed by the Engineer. Liners shall be of 2-flange type or 4-flange type. Liner plate design shall be in accordance with the design criteria for joint strength, stiffness, buckling, and deflection as defined in the

AASHTO Standard specifications for Highway Bridges, latest edition. The liner plate design shall be sufficient for two conditions:

- Construction loading.
- Final structural loading with 75 year service life.

Liner plate shall be fabricated from structural quality, hot-dipped galvanized, bituminous coated steel sheets or plates conforming to ASTM Specification A 569. Plates shall have the following mechanical properties before cold forming: tensile strength = 42,000 psi, yield strength = 28,000 psi, elongation, 2 inches @ 30%. Plates shall be a minimum 12 gage in thickness. Plates shall be accurately curved to suit the tunnel cross section and shall be of uniform fabrication to allow plates of similar curvature to be interchanged.

All plates shall be punched for bolting on both longitudinal and circumferential seams and shall be fabricated as to permit complete erection from the inside of the tunnel. The longitudinal seam shall be of the lap type, with an offset equal to gage of metal for the full width of plate to allow the cross section of the plate to be continuous through the seam. Circumferential hole spacing will be a multiple of plate length to allow staggering of the longitudinal seam.

Grout holes shall be two inches (2") in diameter and shall be provided in the top plates at intervals not to exceed ten feet (10') to permit grouting as the assembly of the liner plate proceeds. Additional plates with nipples are to be installed at top quarter points and sides. Openings shall be staggered. All grout holes shall be tapped or welded with coupling. Tapped holes shall be provided with a pipe plug or screwed in place.

Material shall be galvanized, zinc coated in accordance with ASTM Specification A123, except that the zinc shall be applied at the rate of two (2) ounces per square foot total for both sides.

Bolts and nuts shall be of the diameter and length as recommended by the manufacturer and shall be galvanized to conform to ASTM Specification A153. The materials to be used for the construction of the tunnels shall be new and unused and suitable for the purpose intended.

**B. Surface Settlement Markers.**

1. Within Bituminous Concrete Paved Areas: "p.k." nails.
2. Within Nonpaved Areas: Wooden hubs.

**E. Grout: to fill annular space between tunnel liner and tunnel excavation.**

1. Cement: ASTM C150, Type II.
2. Water: Suitable for Concrete per ACI.
3. Sand: ASTM C404, size No. 1.
4. Masonry Lime
5. Admixture: Bentonite

6. Grout Portions:

One Part: Cement  
Two Parts: Lime  
Four Parts: Sand  
2% Admixture  
Retardant as required  
Water as required

7. Design Mix For Grout: Minimum compressive strength of 100 psi attained within 24 hours.

F. CONCRETE

1. Mix concrete in accordance with ACI 304. Deliver concrete in accordance with ASTM C94.
2. Provide concrete to the following criteria:
  1. Structural Concrete:
    - a. 4500 psi at 28 days.
    - b. Normal weight.
    - c. 3 inch slump +/- 1 inch
    - d. Maximum water-cementitious materials (W/C) ratio, by weight = 0.42.
    - e. Minimum 550 lb. of cement per cu. yd. of concrete.
  3. Cement:
    1. Use Type II cement for concrete construction.
  4. Aggregate Size:
    1. Maximum nominal size of coarse aggregate to be 1/4" except that it is not to be larger than:
      - a. One-fifth narrowest dimension between sides of forms;
      - b. Three-quarters of minimum clear spacing between reinforcing bars.
  5. Use accelerating admixtures in cold weather only when approved by Engineer. Use of admixtures will not relax cold weather placement requirements.
  6. Calcium chloride shall not be used.
  7. Use set retarding admixtures during hot weather only when approved by Engineer.
  8. Add air-entraining agent to normal weight concrete mix for all concrete. Air content shall be 4% to 6%.

G. BRICK

Comply with GDOT requirements.

H. LOW DENSITY CELLULAR CONCRETE

Low Density Cellular Concrete is a mixture of cement, water and preformed foam designed to be pumped into place and finished prior to setting.

## MATERIALS:

1. Cement: The portland cement shall comply with ASTM C150. Pozzolans and other cementitious materials are permitted.
2. Water: Use potable water free from deleterious amounts of alkali, acid, and organic materials which would adversely affect the setting time or strength of the cellular concrete.
3. Fly Ash: The fly ash shall comply with ASTM C618; either Type C or Type F may be used.
4. Admixtures: As required to achieve the density and workability necessary for the application.

## PROPERTIES:

1. Minimum Cast Density 30 PCF +/- 5 PCF
2. Minimum Compressive Strength @ 24 hours 5 psi
3. Minimum Compressive Strength @ 7 days 20 psi
4. Minimum Compressive Strength @ 28 days 40 psi
5. Compressive Strength Range: 40 psi to 100 psi

## PART 3 - EXECUTION

### 3.1 GENERAL

A. Dewatering: When water is encountered, develop and maintain dewatering system of sufficient capacity to remove water continuously, keeping excavations free of water until backfill operation is in progress.

1. Keep removal of soils particles to minimum.
2. Dewater into sediment trap.
3. Observe to detect settlement or displacement of surface facilities due to dewatering.
4. Should settlement or displacement be detected, notify Engineer immediately and act to maintain safe conditions and prevent damage.

### 3.2 DAILY ACTIVITY LOG

A. Maintain daily activity log during tunneling operations for casing. Submit to Engineer for record purposes on a daily basis.

1. Start and finish time of tunnel advancement.
2. Total length of tunnel installed.
3. Horizontal and vertical alignment deviation at not greater than 1 foot intervals or period not exceeding 5 minutes, whichever is most frequent.
4. Maximum jacking force exerted during each push including forces required to re-initiate jacking following periods of system shutdown.
5. General description for each discernible ground condition mined.
6. Settlement monitoring readings.

B. Where tunnel boring system utilizes an electronic data logger, set up so the above information is recorded and can be readily identified.

1. Identify known errors with recorded data and explain in daily log submittal.

### 3.3 PREPARATION

- A. Maintain clean working conditions inside tunneling operation area and remove spoil, debris, equipment, and other material not required for operations.
- B. For construction below railroads, highways and utilities perform installation to prevent interference or disruption with normal operation of these facilities.
- C. During construction, maintain access to private and commercial properties at all times, unless approval from both property owner and Engineer has been obtained.
  - 1. Costs associated with providing alternative access will be at no additional cost.
- D. Provide power generation equipment and other equipment operating on or with fuel or lubrication oils with suitable barriers and safeguards to ensure no loss of oil to drains or waterways or to contaminate ground.

### 3.4 PIT CONSTRUCTION

- A. Responsible for design, construction, maintenance and removal, including any damage attributed to pit construction.
- B. Tunnel Pits: See Working Drawings.
- D. Approximate Locations of tunnel Pits: See Drawings.
- E. Responsible for necessary utility relocation or supporting of utilities for jacking and receiving pits construction.

### 3.5 TUNNELING

- A. Tolerances.
  - 1. Install tunnel with liner to within 6 inch of vertical and horizontal alignment shown on Drawings.
  - 2. Limit annular space, between excavated material and outside diameter of tunnel liner, to maximum of 1-inch.
  - 3. Outside diameter of TBM not to exceed outside diameter of tunnel liner by more than 2 inch.
- B. Obstructions during tunneling.
  - 1. Responsible for selection of type of TBM and type of cutting.
  - 2. Remove, clear, or otherwise make it possible for tunnel system and tunnel liner to progress past or through any obstructions encountered at no additional cost.
- C. Tunneling force
  - 1. No force shall be exerted on tunnel liner without written approval of liner manufacturer.

### 3.6 SPOILS

- A. Remove all spoil material from project site.
- B. Dispose of all materials in accordance with current governmental regulations.

### 3.7 BULKHEAD

- A. Install 3-course brick bulkhead at tunnel entrances.

### 3.8 LINER INSTALLATION

- A. Install self-supporting steel liner plates according to manufacturer's recommendation. Leave

no more than 5 feet unlined while tunneling and leave no more than 1 foot unlined at the end of operations.

- B. Pressure grout voids between tunnel liner and excavation every 10 feet at the end of work shift.

### 3.9 LOW DENSITY CELLULAR CONCRETE

A. Remove any standing water for tunnel. Stabilize water main prior to placement of cellular concrete.

B. Add predetermined quantity of preformed foam to a concrete slurry or grout while mixing to produce cellular concrete.

- C. Place cellular grout to fill annular space in tunnels.

#### Mixing and Conveying:

(1) Use automated job site batching, mixing, and placing equipment. Mix the materials and convey promptly to the point of placement.

(2) Place grout tubes through the annular space to convey the grout to the desired location. Grout tubes should be a minimum 4" diameter and may consist of PVC, HDPE or steel.

(3) Drain pipes or vents should be placed at the lower elevation of the line to allow water to drain out of the annular space. These should be 2" diameter minimum.

(4) Pump cellular concrete until material is discharged through the vent pipes at the opposite end of the line.

(5) Proper pressure gauges shall be used to monitor pump pressures and back pressure.

D. Test concrete density during placement of the initial batches, check the density and adjust the mix as required to obtain the specified density at the point of placement. Test in accordance with ASTM C495 modified.

- E. Sampling each 300 cubic yards of cellular concrete placed or for each ten (10) hours of placing.

### 3.10 SAFETY

A. Provide weekly site visits by Safety Representative with report to Engineer and Owner.

B. Provide weekly training to all employees.

C. Maintain log of all safety activities.

D. Report all safety incidents.

SECTION 02601  
BLW  
WATER MAIN CONSTRUCTION

PART 1 - GENERAL

1.1 SCOPE OF THE WORK

The work includes furnishing all material, labor, tools, equipment, skills, and incidentals necessary to construct water mains of the Marietta Board of Lights and Water's supply system in Cobb County, Georgia.

1.2 ORDER OF WORK

The Contractor will provide a construction plan designating the starting point, or points, for construction and the order in which the work shall be constructed, completed, and placed into operation. The Contractor will submit this plan and the construction schedule as required in Section 01310 prior to the beginning of any construction. The plan will include a disinfection procedure and sequence of disinfection, and sequence for the transfer of services from existing water mains to the new water main. The plan will be submitted to the Engineer and the Owner for review and comment. The Contractor will incorporate the Engineer's and Owner's comments into the construction plan. The plan shall be followed throughout the construction of the water main. It may be modified with the written agreement of the Engineer and the Owner.

1.3 WORK RESTRICTIONS

The Contractor will be restricted in work hours as directed by the Georgia Department of Transportation. It is the Contractor's responsibility to be aware of such restrictions and to plan the work accordingly.

PART 2 - PRODUCTS

2.1 GENERAL

The Contractor shall furnish all materials and incidental items (whether or not they are specifically described herein) necessary to complete all work called for under the contract, except for any items that are specifically listed in these contract documents as being furnished by the Owner.

All materials used in the work including equipment shall be new and unused materials of a reputable U.S. Manufacturer conforming to the applicable requirements of the Specifications, and no materials shall be used in the work until they have been approved by the BLW. Any reference to an AWWA, ANSI or other such specification shall mean the latest revision published.

2.2 PIPE FOR WATER MAINS

2.2.1 Pipe - Pipe for water mains shall be ductile iron (D.I.P.) designed and

manufactured in accordance with the latest revision of ANSI/AWWA C151/A21.51. Each pipe shall be subjected to a hydrostatic pressure test of at least 500 p.s.i., at the point of manufacture. Pipe wall thickness shall be sufficient to meet the above conditions, and in accordance with the Standard Pressure Class 350 requirements.

The Standard Pressure Class or nominal thickness, net weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufactures mark, county where cast, year in which the pipe was produced and the letters "DI" or "Ductile" shall be cast or stamped on each length of pipe.

Ductile Iron Pipe shall have an outside asphaltic coating in accordance with the latest revision of ANSI A21.51-81. The Ductile Iron Pipe shall also have an inside cement lining and asphaltic seal coat in accordance with the latest revision of ANSI/AWWA C104/A21.4 with the following modifications. Cement-mortar lined pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing, disbondment and roughness.

Pipe shall be manufactured by American Cast Iron Pipe Company, United States Pipe and Foundry Company or Griffin Pipe.

2.2.2 Pipe Joints - Pipe joints shall be as the type specified on the project plans. Standard "Push-On" type joints shall be in accordance with the latest revision of ANSI/AWWA C111/A21.11 and furnished complete with gaskets. Where "Push-On" type joints are to be restrained in the size range of 4" to 16", they shall be restrained through the use of "Fast-Grip" gaskets as manufactured by the American Cast Iron Pipe Company or "Field Lok" gaskets as manufactured by the United States Pipe and Foundry Company or an approved equal. Other Restrained Joint Pipe shall be subject to the review by the Engineer.

2.2.3 Inspection and written certification that the pipe meets all applicable specifications will be required in accordance with section 51-4 of ANSI A21.51-81. A written transcript of foundry acceptance tests must be furnished in accordance with section 51-14 of ANSI A21.51-81. These documents must be forwarded to the engineer prior to shipping of pipe.

2.2.4 Fittings shall be ductile iron, and be of a standard design for use with the pipe purchased under these specifications. Fittings shall conform to the latest revision of either ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53. Fittings shall have a standard asphaltic coating on the exterior and shall have a cement-mortar lining on the interior in accordance with ANSI/AWWA C104/A21.4, of latest revision. Fittings shall be of 350 psi pressure class rating.

Fittings and accessories shall be furnished with Mechanical Type Joints in accordance with ANSI/AWWA C111/A21.11, latest revision. Joints shall be restrained with retainer glands as specified another paragraph of this section.

2.2.5 Outlets shall be of the type shown on plans and shall be furnished by the pipe manufacturer.

### 2.3 POLYETHYLENE ENCASUREMENT

Polyethylene encasement for corrosion protection shall consist of three layers of co-extruded linear low density polyethylene (LLDPE) that are fused into one. The inside surface shall be infused with an anti-microbial biocide and a volatile corrosion inhibitor. The encasement shall meet all requirements of ANSI/AWWA C105/A21.5. Tape for polyethylene tubing shall be as provided by the manufacturer for this specific purpose.

### 2.4 BUTTERFLY VALVES

All butterfly valves shall be bubble-tight closing at the rated pressure with flow in either direction, and shall be satisfactory for applications involving throttling service and frequent operations or operations after long periods of inactivity. Valves shall meet the full requirements of AWWA C504, latest revision, for 250 psi working pressure and shall be suitable for above ground or direct buried service. Valves shall be rated and tested for absolute zero leakage shut-off. The closed seat shall be tested to 250 psi and the valve body shall be tested to 500 psi. Owner may require certification of test.

All interior ferrous surfaces of valves shall have an epoxy coating meeting the requirements of AWWA C550. Valve bodies shall be equipped with integrally cast mechanical joint ends meeting AWWA C111.

Butterfly valves installed underground shall come equipped with a manual operator. This manual operator shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering. Operators shall be equipped with mechanical stop-limiting devices to prevent over travel of the disc in the open and closed positions. Valves shall open when turned counter-clockwise. Operators shall be fully enclosed and designed for direct buried operation.

### 2.5 GATE VALVES

Valves 16" and smaller shall be gate valves. The valves shall be of non-rising stem design, and have an iron body, bronze mounted, resilient seated, meeting all requirements of AWWA C509. Valves shall be designed for a minimum working pressure of 250 psi and shall have 2" square operating nuts, except in meter vaults where handwheels shall be installed. Valves shall open when turned counter-clockwise. All interior ferrous surfaces of valves shall have an epoxy coating meeting the requirements of AWWA C550.

Valves sized 6" through 12" shall be Mueller Co. A-2360 with mechanical joints or approved equal. Valves sized 14" through 16" shall be Mueller Co. A-2361 with mechanical joints or approved equal. Where flange joints are used, flanges must meet the requirements of AWWA C115, latest revision.

### 2.6 VALVE BOXES

Valve boxes shall be provided for all buried valves. Valve boxes for valves shall be approved standard cast iron, adjustable-shaft boxes having a minimum shaft diameter of 5-1/4 inches. The casting shall be coated with two coats of coal tar pitch varnish. The

lids of all boxes shall bear the word "Water" or the letter "W". Boxes shall be equal to Vulcan Pattern VVB-4. Valve boxes shall be flush with the final grade after grading and / or paving.

## 2.7 VALVE MARKER

One concrete valve marker shall be furnished and set at each line valve. The marker shall be made of 3000 psi concrete and shall be four (4) feet long and 4" on each side, with #4 reinforcing bars as shown on the detail.

The markers shall be set an even number of feet between the center line of the valve and the center line of the aluminum disc in the top of the marker, and the distance in feet between the valve and marker shall be stamped in the marker at the time of setting.

## 2.8 FIRE HYDRANT

All fire hydrants shall comply in all respects with BLW Standards and shall be designed and manufactured to comply with the latest revision of AWWA C502. The hydrants shall be designed for 250 pounds working pressure, of simple design, easy to operate, effectively and positively drained and protected from damage by freezing, and convenient for repairing and replacing parts.

Hydrants shall be equipped with one 4-1/2" pumper nozzle and two 2-1/2" diameter hose connections, which shall have threads meeting the latest requirements of the State Fire Insurance Commission. Hydrants shall have a safety flange on the barrel and a safety coupling on the valve stem, to prevent damage to barrel and stem in case of traffic accident. Fire hydrants shall be M&H Valve and Fitting Co., Traffic Model Style 129, or Mueller Super Centurion Model A421.

The connection at the base of the hydrant shall be mechanical joint with ductile iron retainer gland for 6" ductile iron pipe. The valve opening shall meet the requirements of the AWWA Specifications for a 5-1/4" hydrant. The valve, valve seat and inner working parts shall be easily accessible. The height from the surface of the ground to the bottom of the pumper nozzle shall be no less than 18". Each hydrant shall be neatly painted with a silver reflecting paint.

Each hydrant shall be tested to 250 psi. The first test shall be made with the valve closed. The second test shall be made with the main valve open but all nozzles closed. While the test is being carried on, the hydrant shall be subjected to a hammer test. Any hydrant showing defects by leakage, sweating, or otherwise shall be rejected. The barrel and all parts shall withstand these tests. These tests shall be made in the field after the hydrants are installed.

Leads from the main line to the fire hydrant shall use 6" ductile iron pipe and shall have a 6" gate valve between the main line and fire hydrant. The valve shall be connected to the main line by using a locked hydrant tee. Whenever possible, the hydrant shall be connected to the valve by using a locked hydrant adapter.

## 2.9 AIR AND VACUUM RELEASE VALVES

The air release and vacuum break valve shall be of the compact single chamber design with solid cylindrical HDPE control floats housed in a tubular stainless steel body with epoxy powder coated cast iron or steel ends secured by stainless steel tie rods. The valve shall have an integral orifice mechanism which shall operate automatically to limit transient pressure rise induced by closure to twice valve rated working pressure. The intake orifice shall be equal to the nominal size of the valve. Large orifice sealing shall be affected by the flat face or the control float seating against a nitrile rubber o-ring housed in a dovetail groove circumferentially surrounding the orifice. Discharge of the pressurized air shall be controlled by the seating and unseating of a small orifice nozzle on a natural rubber seal affixed into a control float. The nozzle shall have a flat seating land surrounding the orifice so that damage to the rubber seat is prevented. All components shall be easily replaced. Connection to valve inlet shall be NPT.

The valve shall be Vent-O-Mat series RBX or approved equal. Gate valves between water main and air release valve shall be bronze, solid wedge with screw connection equal to Jenkins Company Figure 370. Meter box shall be equal to the DFW Style D-1200 or approved equal.

#### 2.10 RETAINER GLANDS

Retainer glands for mechanical joints shall utilize standard gaskets and bolts conforming to AWWA C111 and shall be EBAA Mega-Lug or approved equal.

#### 2.11 STEEL CASING

Casing pipe shall be steel pipe conforming to ASTM Designation A-139, Grade B, electric fusion welded steel pipe. The pipe shall have minimum yield strength of 35,000 psi. The exterior and interior of the pipe shall have a coal tar varnish coating. Wall thickness shall be as shown on plans with a minimum wall thickness of 0.250".

#### 2.12 CASING SPACERS

Casing spacers shall be Model CCS stainless steel as manufactured by Cascade Waterworks Mfg. Co. of Yorkville, Illinois, or approved equal. All insulators shall have a stainless steel shell. Insulators shall be located within 2' of each end of the casing and spaced no more than 10' apart within the casing. The positioning of the casing insulators shall be centered. Spacers shall be sized as recommended by the manufacturer.

#### 2.13 SUBGRADE STABILIZER

Subgrade stabilizer shall consist of crushed stone meeting size and gradation requirements for Georgia D.O.T. #57 designation.

#### 2.14 CONCRETE

Concrete for blocking, replacing curb and gutter, replacing sidewalks and miscellaneous concrete shall have a minimum compressive strength of 3000 pounds at 28 days.

2.15 CONCRETE AND GROUT

A mix design, showing amounts of each ingredient for each type mix, shall be submitted for approval.

2.16 SAND FOR BACKFILL

Sand for backfilling over water mains, when required, shall be coarse, well-graded sand relatively free from dirt and other foreign matter. Sand shall be approved by the Engineers.

2.17 BRICK

All brick shall be best grade. All hard burned common, acceptable to the Engineers and giving a ringing sound when struck and presenting a regular and smooth face, shall be used. When submerged in water for 24 hours, they will not absorb more than 10% of their weight in water.

Bricks shall be culled when delivered on the site and all imperfect brick are to be immediately removed from the work. All salmon, soft or arch brick or brick made of alluvial soil will be rejected. All brick used in the work shall be of uniform size.

2.18 BITUMINOUS PAVEMENT REPLACED

Pavement shall be replaced in accordance with the details shown on the drawings and as set out under "Removing and Replaced Pavement - Bituminous Paving" under section for construction methods. All bituminous materials and workmanship shall conform to the latest standard specifications of the Georgia Department of Transportation for Type "F" surface course.

2.19 TAPPING SLEEVE AND TAPPING VALVES

Tapping sleeves shall be rated for 250 psi and shall be a Mueller H-615, PowerSeal 3490MJ or approved equal.

Tapping valves shall be Mueller, mechanical joint, 250 psi, T-2360, or approved equal.

2.20 PIPE CONNECTION COUPLINGS

Pipe connections between new pipe and existing pipe shall be made with compression couplings for pipe sizes 2" and below. Compression couplings shall have lock down screws such as provided by the Ford C45-77 or the Ford C44-77. For pipe sizes above 2", M.J. solid sleeves (long style) shall be used. Spacer rings must be used at all solid sleeve locations. A spacer ring is defined as a short section of pipe cut to fit into the gap between the two plain ends of pipe at the sleeve location. The remaining clearance must be a maximum of 1/4".

## 2.21 COPPER TUBING FOR SERVICES

House water service pipe shall be copper service pipe, type K, soft temper, seamless copper tubing, conforming to ASTM B-88. Flare joints shall be used for ¾" and 1" services. Compression joints shall be used on 2" services, including stainless steel clamp screws. Couplings shall be Ford C44-77 or approved equal.

## 2.22 CURB STOPS AND WYES

All metal parts of curb stops shall be made of bronze. The cock shall be operated with a combined cap and tee and shall open when turned counter-clockwise. All curb stops shall have locking device. Curb stops smaller than 2" shall have a flare by female iron pipe connection. These curb stops shall be Ford Model B21-444W or approved equal.

Curb stops 2" in size shall have a compression joint inlet with flange outlet, and the compression end shall also have a stainless steel clamp screw. These curb stops shall be Ford Model BF43-777W or approved equal.

Where approved for use, wyes shall be Ford model Y22-247 or approved equal.

## 2.23 CORPORATION COCKS

Corporation cocks smaller than 2" in size shall have an AWWA tapered thread inlet and flare outlet connection. All metal parts of the cock assembly shall be made of bronze. The cock shall be operated with a tee head and shall open when turned counter-clockwise. The cock shall be a Ford model FB600 or approved equal. Services 1" and smaller in diameter shall be direct tapped.

## 2.24 METER BOXES

Meter boxes for services shall be made of polypropylene materials. The box shall be approximately 19" long, 13" wide and 12" deep. The lid shall be made of the same material as the box, and shall have an AMR locator pad attached to the bottom of the lid to accept AMR transponders. The lid shall seat securely and evenly inside the meter box and shall not overlap the top edge of the box. Meter Boxes shall be DFW Plastics Series A 1200.SBAMR or approved equal.

## 2.25 SERVICE SADDLES

Service saddles shall be equal to Smith-Blair 313 double strap clamps suitable for use with ductile iron or PVC pipe. Direct taps are required for all ¾ inch and 1 inch service connections. Service saddles are required for taps larger than 1" in diameter.

## 2.26 METERS

Water meters shall be furnished and installed by the BLW. All meters must be capable of reading accurately at low flows. All meters shall read in gallons. All meters shall come equipped with a touch-read or radio-read compatible with the BLW's meter reading equipment. The bypass shall be located inside the vault.

## 2.27 PRESSURE REDUCING VALVE

Pressure reducing valves shall be Watts Regulator 25 AUB or approved equal.

## 2.28 BACKFLOW PREVENTERS

In accordance with the BLW's Cross Connection Control Program, water service customers may be required to have a backflow prevention device selected on the basis of the customer's risk categorization as determined by the BLW. The backflow preventers listed below meet the current BLW requirements; other manufacturer's devices that meet the requirements listed in parentheses are acceptable if approved by the BLW.

### 1" - 2" Lines

Low Risk - Ford Model HHS31-323 or approved equal. (ASSE 1024)

Medium Risk - Hersey Model FDC or approved equal. (ASSE 1015, AWWA C510, USC)

High Risk - Hersey Model FRP II or approved equal. (ASSE 1013, AWWA C511, USC)

### 2 1/2" - 10" Lines

Low Risk -Wilkins Model 950 or approved equal. (ASSE 1015, AWWA C510, USC)

Medium Risk -Wilkins Model 950 or approved equal. (ASSE 1015, AWWA C510, USC)

High Risk -Wilkins Model 975 or approved equal. (ASSE 1013, AWWA C511, USC)

The initials of specification-issuing agencies shall be understood to mean the organization listed below:

ASSE: American Society of Sanitary Engineering

AWWA: American Water Works Association

USC: University of Southern California Foundation of Cross Connection Control and Hydraulic Research

## 2.29 GENERAL REQUIREMENTS FOR LEAD

Any pipe, solder or flux used in the installation or repair of the water lines must be lead-free. Pipes and fittings must not contain more than 8.0% lead and solders and flux must not contain more than 0.2% lead.

## 2.30 GEOGRID SOIL REINFORCEMENT

Geogrid soil reinforcement is an artificial grid formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement. It shall be Tensar Biaxial Geogird BX1200 or approved equal.

## 2.31 STRUCTURAL CONCRETE

Concrete shall meet the following requirements:

	Concrete
Cement content -Minimum number of sacks (94 lb.) per cubic yard	6
Maximum water to cement ratio (gal. Water per sack cement)	5.1
Entrained air	3% - 6%
Minimum Superplasticizer content per 100 lbs. of cement	45 oz.
Minimum 7 day compressive strength	2,400 psi
Minimum 28 day compressive strength	4,000 psi

### 2.32 FORM WORK

Forms shall result in a final structure, which conforms to the shape, lines, and dimensions of the members as required by the plans and specifications, and shall be substantial and sufficiently tight to prevent leakage of mortar. They shall be properly braced or tied together so as to maintain position and shape. Forms and their supports shall be designed so that previously placed structure will not be damaged.

Form ties shall be so designed that when the forms are removed no metal shall be within 1-1/2 inches of the finished surface. Form ties shall have an approved type waterstop that is an integral part of the tie and made of the same material as the tie. Gang form ties shall be filled from one end with a compressible plug a minimum of 1 1/2 inches from the edge of wall shall have a bentonite plug in the center of the wall and all voids filled with non-shrink grout. Removal of forms and shores - no construction loads exceeding the dead load plus live load shall be supported on any unshored portion of the structure under construction. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with the remaining forming and shoring system has sufficient strength to support safely its weight and the loads placed thereon. This strength may be demonstrated by job-cured test specimens and by a structural analysis considering the proposed loads in relation to these test strengths and the strength of the forming and shoring system. Such analysis and test data shall be furnished by the contractor to the Engineer when so required. In no case shall forms for walls or columns be removed in less than 36 hours. Formwork supporting weight of concrete, such as beams and slabs shall remain until the concrete has attained a minimum of the 28-day design strength.

The design and engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor. Except as specifically called for otherwise herein, all formwork shall meet the "ACI Standard Recommended Practice for Concrete Form work (ACI 347-68)".

Chamfer: Unless shown otherwise, form chamfers with 3/4" x 3/4" strips, accurately formed to produce uniformly straight lines and tight edge joints on exposed concrete. Extend terminal edges to required limit and miter chamfer strips at changes in direction. All exposed corners shall be chamfered.

### 2.33 REINFORCING STEEL

Reinforcing steel shall comply with ASTM A615-90.

### 2.34 TRAFFIC STRIPE

Materials used in placing traffic stripes shall be thermoplastic and shall comply with Georgia DOT Specification 653, latest revision.

### 2.35 EROSION CONTROL MATS

A. Erosion control mats for slopes and waterways shall comply with the requirements stated on the Contract Drawings.

B. Turf reinforcement mat for slopes and water ways shall withstand a maximum velocity of 10 ft/s in an unvegetative state, and 20 ft/s in a vegetative state. The mat shall be designed to be installed on a 1:1 or greater slope. The turf reinforcement mats shall be PYRAMAT High Performance Turf Reinforcement Mat's produced by LANDLOK, Permanent Turf Reinforcement Mat's produced by Vmax<sup>3</sup>, or approved equivalent material and manufacturer.

### 2.36 SELECT BORROW

Material which excavated from borrow areas or pits outside the Project and hauled and utilized within the Project shall be Class IIB3 or better in accordance GDOT Standard Specifications. Prior to any utilization of any such material, the material source and characteristics shall be submitted to the Engineer for approval.

### 2.37 FLOWABLE FILL

Controlled low strength flowable fill shall comply with GDOT Specification Section 600. A concrete mix design shall be submitted to the Engineer for approval prior to use. The flowable fill shall consist of Portland cement, fly ash, fine aggregate, air-entraining admixtures, and water proportioned to provide low strength, self-leveling backfill material.

### 2.38 LOCATOR BALLS

Locator balls shall be manufactured by 3M. The model number shall be 1423-XR/iD, corresponding to the 3M EMS iD Ball Marker product.

## PART 3 - EXECUTION

### 3.1 CLEARING AND GRUBBING

Where necessary, the construction zone will be cleared to allow trenching and pipe laying operations. Clearing will be restricted to easement limits shown on plans, plus areas within the highway right-of-way. The cleared area shall be left free of stumps, limbs, rocks and other debris. Cleared areas in forested zones will be left in a condition

suitable for bush-hog cutting; areas adjacent to lawns shall be left suitable for lawn mower cutting and at least in as good a condition as the adjoining property. Trees, brush, stumps and other debris from clearing and grubbing shall be disposed of in accordance with local ordinances (which place restrictions on burning); burial within the right-of-way or easement will not be permitted.

The Contractor is responsible for restoring any property (shrubs, signs, sidewalks, paving, trees, structures, etc.) that is damaged by his operations. It is understood that any item which is not specifically listed as a pay item but which exists at the time the project is bid is included in the overall bid price.

### 3.2 FENCES

The Contractor shall take down fences on or crossing right-of-way for such periods of time only as are necessary to prosecute the work of clearing, grubbing, trenching, pipe laying and backfilling. Gaps made in fences shall be closed in substantial manner at night and during any suspension of work, and, upon completion of the pipeline, fences shall be restored to as good condition as before disturbed. No charges shall be made by the Contractor for any expense incurred in taking down or restoring fences, except where listed in the bid proposal.

### 3.3 PROTECTION OF TREES

The Contractor shall remove only such trees on or along the work as necessary, and shall carefully protect all other trees adjacent to the work. He shall not permit excavating machinery or trucks to scrape the bark or tear the limbs from the trees, nor connect ropes or guy cables to them.

### 3.4 INTERFERENCE WITH EXISTING STRUCTURES

All existing pipes, drains, or other structures on, above, or below ground shall be carefully supported and protected from injury, and if injured, they shall be restored in a satisfactory manner by and at the expense of the Contractor.

### 3.5 INFORMATION CONCERNING CONDITIONS

The accuracy of information furnished by the Engineer and/or the plans and specifications as to underground and surface structures, foundation conditions, character of soil, position and quantity of ground and subsoil water, etc., are not guaranteed by the Owner. Bidders must satisfy themselves by personal examination and by such other means as they desire with respect to actual conditions in the nature of the ground and subsoil water and in regard to the locations of existing underground or surface structures. Unforeseen conditions shall not constitute a claim for increased compensation under the terms of the contract, nor constitute a basis for the cancellation thereof.

### 3.6 LOCATION AND PROTECTION OF EXISTING UNDERGROUND UTILITIES

It is the responsibility of the Contractor to locate the underground utilities and to protect same. Utility lines or services damaged by the Contractor shall be repaired by the

Contractor at his own expense.

### 3.7 INTERRUPTION OF WATER SUPPLY DURING CONSTRUCTION

A minimum of 24 hours advance notice shall be given to any occupied building served by a water line which is required to be shut off. Occupants shall be informed of the date, time of cutoff and the duration of stoppage. Failure to do so will make the Contractor liable for any damages reported to the BLW's Office. For outages affecting several customers, 24 hours notice shall be prepared and given to the affected customers and must be coordinated with the BLW.

### 3.8 CLEAN UP

The Contractor shall remove all unused material, excess rock and earth, and all other debris from the construction site as closely behind the work as practical. All trenches shall be backfilled and tamped before the end of each day's work.

If at any time during the course of the work, the clean up, grassing and/or pavement replacement falls too far behind the pipe laying (at the discretion of the Engineer) the Contractor shall be required to close down pipe laying operations until the clean up, grassing and/or pavement replacement is caught up to the work in progress.

### 3.9 TRENCH EXCAVATION

Trenches shall have a minimum width of twelve (12) inches plus the diameter of the outside of the bell of the water main. The trench shall be of a depth such that the top of the water main is a minimum of 48" below grade, 48" below the edge of pavement, or 36" below the drainage ditch paralleling the road, whichever is deepest. Maximum trench width at the top of the pipe shall not be more than the outside diameter of the bell plus two feet. In cases where water lines cross sanitary sewers, there shall be a minimum of 18 inches vertical separation between the water and sewer mains. At crossings, one full length of water pipe must be located so that both joints are as far from the sanitary sewer as possible. In cases where water mains parallel sewer mains there shall be a minimum of ten (10) feet horizontal separation maintained between the mains. These distances are measured edge to edge.

Pipe trenches shall be straight and true to grade and in the location shown on the plans. Trenches shall be dug so that the pipe can be laid to the alignment and depth required, and the trench shall be of such width and shall be braced and drained so that the workmen may work therein safely and efficiently. No chocking under the pipe will be permitted. All joints shall be as specified herein. Excavation must be made under the bell of each pipe so that the entire length of the pipe will lie uniformly on the bottom of the trench and the pipe weight shall not rest on the bells. Trenches shall be free of water during the work.

All changes in grade shall be made gradually. At points of interference with storm sewers and cross drains on D.O.T. right-of-way, the pipe will be run under the conflicting utility. Where the water main crosses beneath a storm sewer, there shall be a minimum of 12" clearance between the main and the storm sewer. Where necessary, the line shall be lowered at valves so that the top of the valve stem is approximately one foot

below the finished grade. The trench shall be deepened to provide a gradual approach to all low points of the line.

In laying pipe across water courses, railroad crossings, or depressions of any kind, the minimum depth here specified shall be maintained at the bottom of the depression. Railroad crossings shall be installed according to American Railway Engineering Association requirements.

No excavation shall be made under highways, streets, alleys or private property until satisfactory arrangements have been made with the State, City, County or owners of the property to be crossed. All excavated material shall be placed so as to not interfere with public travel on the streets and highways along which the lines are laid. Not more than 100 feet of trench shall be opened on any line in advance of pipe laying.

Wherever streets, roads, or driveways are cut, they shall be immediately backfilled and compacted after the pipe is laid and shall be maintained in first-class condition as passable at all times until repaved. Backfilling, compaction, dressing and clean-up shall be kept as close to the line laying crew as is practical, and negligence in this feature of the work will not be tolerated.

In excavation and backfilling and laying pipe, care must be taken not to remove or injure any water, sewer, gas or other pipes, conduits or other structures. When an obstruction is encountered, the Contractor shall notify the Owners of the obstruction to adjust same or make necessary changes in grade and/or alignment to avoid such obstruction. Any house connection, drains or other structures damaged by the Contractor shall be repaired or replaced immediately.

All excavation shall be placed on one side of the trench. Excavation materials shall be so placed as not to endanger the work and so that free access may be had at all times to all parts of the trench and to all fire hydrants or water valve boxes, etc. All shade trees, shrubs, etc., shall be protected. All excavation material shall be so placed so as not to interfere with public travel on the streets and highways along which the lines are laid. All excess excavated material shall be disposed of without extra cost to the Owner.

The Contractor shall furnish, install and maintain such sheathing, bracing, etc., as may be required to support the sides of the excavation and to prevent any movement that might injure the pipe, or cause sloughing of the street or trench, or otherwise injure or delay the work or interfere with adjoining structures.

### 3.10 LAYING PIPE

All pipe, before being placed in trench, shall be examined, and any pipe showing defects shall be rejected. The inside of the pipe shall be clean and free of trash and dirt, and if necessary a swab or brush shall be used to clean the pipe before lowering it into the trench.

All pipe shall be laid straight, true to line and grade. For all laying conditions, bell and coupling holes shall be dug to allow the pipe to have continuous bearing with bedding throughout the entire length of the barrel between bell or coupling holes. No shimming or blocking up of the pipe will be allowed. All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of the day's work or for

other reasons, such as rest breaks or meal periods. Trench dewatering methods (gravel bedding with pumps, etc.) must be used where necessary to maintain a dry ditch during pipe laying operations.

In making ductile iron joints, the outside of the spigot end of the pipe and the inside of the bell shall be thoroughly cleaned and the gasket inspected to see that it is properly placed. Lubricant shall be applied to the spigot end of the pipe and it shall be inserted into the bell of the adjoining pipe to the "Stop Mark" shown on the pipe. Joint deflection shall be checked by Contractor for compliance with the pipe manufacturer's recommended limits.

### 3.11 BACKFILLING

After the pipe has been laid, backfilling shall be done in two (2) distinct operations. In general, all backfill beneath, around and to a depth of twelve (12") inches above the top of the pipe shall be placed by hand in four (4") inch layers for the full width of the trench and thoroughly compacted by hand with vibratory equipment. The remainder of the backfill shall be placed in 6" layers and compacted to the top of the trench, either by pneumatic hand tamps, hydro-tamps, or other approved methods. Care shall be taken so that the pipe is not laterally displaced during backfilling operations. The backfill lifts shall be placed by an approved method in accordance with that hereinafter specified. Backfill materials shall be the excavated materials without bricks, stone, foreign matter or corrosive materials, where not otherwise specified on the plans.

Backfill under permanent concrete or bituminous pavement and as elsewhere specified or indicated on the plans shall be approved bank run sand or gravel or crushed stone free from large stones and containing not more than ten percent (10%) by weight of loam or clay. This backfill shall be compacted to one hundred percent (100%) as determined by the Standard Proctor test for the top two (2) feet of trench and ninety five percent (95%) by the Standard Proctor test from pipe bedding to two (2) feet below trench top. Mechanical vibrating equipment shall be used to achieve the required compaction. Pavement shall be replaced immediately after the backfilling is completed.

Backfill in unpaved areas shall be compacted with mechanical vibrating equipment to ninety-five percent (95%) as determined by the Standard Proctor Test. Backfill material from pipe bedding to ground surface by shall be excavated earth free from large stones and other debris.

Contractor shall fully restore and replace all pavement, surface structures, etc., removed or disturbed as part of the work to a condition equal to that before the work began.

Where sheeting is used in connection with the work, it is in no case to be withdrawn before the trench is sufficiently filled to prevent damage to banks, road surfaces, adjacent pipes, adjacent structures or adjacent property, public or private.

Rock in trenches shall be excavated over the horizontal limits of excavation and to depths as follows:

<u>Size of Pipeline Inches</u>	<u>Depth of Excavation Below Bottom of Pipe, Inches</u>
6	6
8 to 18	8
18 to 30	10
Over 30	12

After the pipe has been laid and all joints have been made, the trench shall be backfilled as described on the detail sheet of the construction plans for the various laying conditions. Under no circumstances shall bottom of pipe rest against rock or unyielding material. Minimum bedding of 4" carefully compacted backfill shall separate bottom of pipe from rock or unyielding material.

### 3.12 POLYETHYLENE ENCASUREMENT

Where polyethylene encasement is shown on plans, it shall be installed in accordance with AWWA C105, Section 4.3 "Method A" as follows:

Cut polyethylene tube to a length approximately 2 ft. longer than that of the pipe section. Slip the tube around the pipe, centering it to provide a 1ft. overlap on each adjacent pipe section, and bunching it accordion fashion lengthwise until it clears the pipe ends.

Lower the pipe into the trench and make up the pipe joint with the preceding section of pipe. A shallow bell hole must be made at joints to facilitate installation of the polyethylene tube.

After assembling the pipe joint, make the overlap of the polyethylene tube. Pull the bunched polyethylene from the preceding length of pipe, slip it over the end of the new length of pipe, and secure it in place. Then slip the end of the polyethylene from the new pipe section over the end of the first wrap until it overlaps the joint at the end of the preceding length of pipe. Secure the overlap in place. Take up the slack width to make a snug, but not tight fit along the barrel of the pipe, securing the fold at quarter points.

Repair any rips, punctures, or other damage to the polyethylene with adhesive tape or with a short length of polyethylene tube cut open, wrapped around the pipe, and secured in place. Proceed with installation of the next section of pipe in the same manner. If a second layer of polyethylene encasement is called on the plans, it shall be installed in the same manner as the first.

Cover bends, reducers, offsets, and other pipe-shaped appurtenances with polyethylene in the same manner as the pipe.

When valves, tees, crosses, and other odd-shaped pieces cannot be wrapped practically in a tube, wrap with a flat sheet or split length of polyethylene tube by passing the sheet under the appurtenance and bringing it up and around the body. Make seams by bringing the edges together, folding over twice, and taping down. Handle width and overlaps at joints as described above. Tape polyethylene securely in place at valve-stem and other penetrations.

Provide openings for branches, service taps, blow-offs, air valves, and similar appurtenances by making an X-shaped cut in the polyethylene and temporarily folding back the film. After the appurtenance is installed, tape the slack securely to the appurtenance and repair the cut, as well as any other damaged areas in the polyethylene, with tape.

### 3.13 ROCK EXCAVATION

All material shall be considered as trench rock, which cannot be excavated with a backhoe having a bucket curling force rated at not less than 33,010 pounds (Caterpillar Model 225B or equivalent).

The Contractor shall notify the Engineer when rock is encountered. Measurement of rock will normally be made from rock profile on the trench wall after excavation. Rock in trenches shall be excavated over the horizontal limits of excavation and to depths as follows:

Size of Pipeline Inches	Depth of Excavation Below Bottom of Pipe, Inches
6	6
8 to 18	8
18 to 30	10
Over 30	12

Rock will be removed to the specified depth below normal bottom and this area below the pipe will be backfilled with select material.

All material shall be considered as casing rock, which cannot be excavated by normal boring operations including the use of a rocking head and requires blasting. Measurement of rock volume requiring blasting will normally be made based upon area of casing times actual length of casing installed in rock. Contractor shall notify engineer when casing rock is encountered.

Rock excavation by blasting shall be at least 75 feet in advance of pipe laying.

Before blasting, the Contractor shall cover the excavation with heavy timbers and mats in such manner as to protect the adjacent property Owners from damage. The Contractor will be held responsible for all damage done.

### 3.14 THRUST RESTRAINT

#### 3.14.1 GENERAL

At changes in direction of the main and at other points shown on the plans or directed by the Engineer, thrust forces in the line shall be absorbed by restrained joints, concrete blocking, or reinforced concrete collars, or a combination thereof.

#### 3.14.2 RESTRAINED JOINTS

Where restrained joint are called for on the construction plans, they shall be of the type specified and shown on drawings, and assembly shall be in accordance

with manufacturer recommendations.

### 3.14.3 CONCRETE BLOCKING

The Engineer shall be notified by the Contractor before blocking is placed. Blocking will be of the dimensions called for on the construction plans and will be placed against a vertical surface of undisturbed soil that has been cleared of all loose material.

### 3.14.4 REINFORCED CONCRETE COLLARS

Reinforced concrete collars shall be cast in place as shown on detailed plans and as specified in ACI 318-83.

## 3.15 LEAKAGE TEST

### 3.15.1 PRESSURIZATION

After the pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure of 1.5 times the working pressure at the point of testing. Each valved section of pipe shall be slowly filled with water, and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the owner. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure. It is good practice to allow the system to stabilize at the test pressure before conducting the leakage test.

### 3.15.2 AIR REMOVAL

Before applying the specified test pressure, air shall be expelled completely from the pipe, valves, and hydrants. If permanent air vents are not located at all high points, the contractor shall install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and plugged or left in place at the discretion of the owner.

### 3.15.3 LEAKAGE DEFINED

Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section.

### 3.15.4 ALLOWABLE LEAKAGE

No pipe installation will be accepted if the leakage is greater than 15 gallons per day per inch diameter per mile of pipeline. This rate is shown in the following

table:

ALLOWABLE LEAKAGE PER 1,000 FEET OF PIPELINE  
(Based on 15gpd/in/mile)

Pipe Diameter (inches)	Allowed Leakage Per Day (Gallons)	Allowed Leakage Per Hour (Gallons)
6	17.0	0.71
8	22.7	0.95
10	28.4	1.18
12	34.1	1.42
14	39.8	1.66
16	45.5	1.89
20	56.8	2.37
24	68.2	2.84
30	85.2	3.55
36	102.3	4.26
42	119.3	4.97
48	136.4	5.68
54	153.4	6.39
60	170.5	7.10

### 3.15.5 TEST RESTRICTIONS

The hydrostatic test shall be of at least 2-hour duration. Test Pressure shall not vary by more than +5 psi for the duration of the test; this may require periodic pumping.

Valves shall not be operated in either direction at differential pressure exceeding the rated valve working pressure. Use of a test pressure greater than the rated valve pressure can result in trapped test pressure between the gate of a double-disc gate valve. For tests at these pressures, the test setup should include provision, independent of the valve, to reduce the line pressure to the rated valve pressure on completion of the test. The valve can then be opened enough to equalize the trapped pressure with the line pressure, or fully opened is desired.

Test pressure shall not exceed the rated pressure of the valves when the pressure boundary of the test section includes closed, resilient-seated gate valves or butterfly valves.

### 3.16 DISINFECTION

After leakage testing, and all necessary repairs have been made, the lines shall be flushed clean and then disinfected in strict accordance with AWWA Standard For Disinfecting Water Mains, C651-92, subject to the following special conditions:

3.16.1 The method of disinfection shall be either the Continuous-Feed Method or the Slug Method. The Tablet Method is not acceptable.

- 3.16.2 The form of chlorine may be either: (1) a 1 percent solution made from either sodium hypochlorite or calcium hypochlorite and pumped and metered into the pipeline; or (2) liquid chlorine fed from a pressurized cylinder through a gas-flow chlorinator and metered into the pipeline. With either form, water must be flowing during the feeding operation and the injection point must be located so that the flow of water will disperse the chlorine throughout the pipeline.
- 3.16.3 The Contractor shall provide a written record of free chlorine residual in the pipeline at the beginning of the chlorination period and at the end of the chlorination period. If the free chlorine residual is below the minimum value required by the appropriate test method, the pipeline shall be rechlorinated.
- 3.16.4 All flushing, disinfection, sampling and dechlorination work must be witnessed by an authorized representative of the Owner.
- 3.16.5 Unless otherwise approved by the Owner, Contractor shall dechlorinate the highly chlorinated water being flushed from the pipeline.
- 3.16.6 The Owner shall be responsible for bacteriological sampling and testing water from the disinfected pipeline.
- 3.16.7 Before any flushing or disinfection work is begun, the Contractor shall outline his planned procedures for these tasks in writing, and obtain approval of the Owner prior to the commencing with the work.
- 3.16.8 If bacteriological testing shows the presence of coliform bacteria, then the Engineer may require additional testing to be performed until two consecutive samples are negative or require additional flushing and disinfection of the water main as required to obtain the two consecutive negative bacteriological samples.

3.17 DECHLORINATION

After the disinfection process has been completed, the heavily chlorinated water shall be flushed from the main until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system or is acceptable for domestic use. The area where the chlorinated water is to be discharged shall be inspected. If there is any possibility that the chlorinated discharge will cause damage to the environment, then a neutralizing chemical shall be applied to the water to be wasted to neutralize thoroughly the chlorine residual remaining in the water.

The chlorine residual of water being disposed may be neutralized by treating the water with one of the chemicals listed in the table below:

Chemical Required				
Residual Chlorine Concentration mg/L	Sulfur Dioxide (SO <sub>2</sub> ) lb (kg)	Sodium Bisulfite (NaHSO <sub>3</sub> ) lb (kg)	Sodium Sulfite (Na <sub>2</sub> SO <sub>3</sub> ) lb (kg)	Sodium Thiosulfate (Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> ·5H <sub>2</sub> O) lb (kg)

1	0.8	(.36)	1.2	(.54)	1.4	(.64)	1.2	(.54)
2	1.7	(.77)	2.5	(1.13)	2.9	(1.32)	2.4	(1.09)
10	8.3	(3.76)	12.5	(5.67)	14.6	(6.62)	12.0	(5.44)
50	41.7	(18.91)	62.6	(28.39)	73.0	(33.11)	60.0	(27.22)

Amounts of chemicals required to neutralize various residual chlorine concentrations in 100,000 gal (378.5 m<sup>3</sup>) of water.

### 3.18 CONNECTION TO EXISTING WATER MAINS

At beginning of construction, the Contractor shall make exploratory excavation at each location where connections to existing pipes are shown for the purpose of determining the exact location, elevation, size, and type of fittings required to make the connections. Where it is necessary to disrupt service on existing lines, the Contractor shall first obtain permission from the Owner and schedule his work accordingly.

Where existing pipe is to be abandoned, the Contractor shall plug the opening by pouring concrete in and around the opening as needed to completely seal the opening.

### 3.19 SETTING VALVES

Valves shall be placed where shown on the plans or directed by the Engineer.

Valves shall be set plumb, and shall have cast iron valve boxes and/or manholes as called for on the plans. The valve boxes shall be placed directly over the valve and set plumb, the top of the box being brought to the surface of the ground. After the boxes are in place, earth shall be filled in the trench and thoroughly tamped around the box, and after all settlement has taken place, each valve box shall have a concrete collar as shown on the plans.

### 3.20 MARKING LOCATION OF VALVES

Each main line water valve shall be marked by cutting a letter "V" in the curb. The "V" shall be turned to point toward the valve. The letter height shall be 6".

Concrete valve markers shall be set for main line water valves with an even number of feet between the center line of the valve and the center line of the aluminum disc in the top of the marker, and the distance in feet between the valve and marker shall be stamped in the marker at the time of setting.

### 3.21 AIR AND VACUUM ASSEMBLIES

Air and vacuum relief valve assemblies shall be constructed strictly in accordance with the details shown on the plans.

### 3.22 INSTALLATION OF SOLID SLEEVES

Spacer rings must be used with all solid sleeves and no exceptions will be allowed. The

maximum clearance allowed will be ¼".

### 3.23 FLANGED OUTLETS

Where flanged outlets are shown on the plans, they shall be installed as recommended by the manufacturer. When attaching a valve to the outlet, the valve and tapping machine, when used, shall be supported to relieve stress on the outlet fixture. The hole in the ductile iron pipe may be cut by either a mechanical tapping machine or by use of a cutting torch.

### 3.24 RETAINER GLANDS

When installing the retainer gland, clean the inside of the pipe bell and lubricate both the gasket and the spigot end of the pipe. Place the gland on the plain end with the lip extension toward the plain end, followed by the gasket. Insert the pipe into the pipe bell and press the gasket firmly and evenly into place. Keep the joint straight during assembly. Push the gland toward the pipe bell and center it on the pipe with the gland lip against the gasket. Install bolts and hand tighten nuts. Make any required deflection after joint assembly and before the bolts are tightened. Tighten the bolts to the manufacturer's recommendation for the gland size. Tighten the twist-off bolts per manufacturer's recommendation. Should removal of this application be necessary, this should be done in accordance with manufacturer's recommendation.

### 3.25 SPECIALS AND FITTINGS

Specials and fittings shall be properly braced to insure that they will not be blown off or broken loose under the greatest possible working pressure. Where it is necessary to use concrete to block vertical bends, etc., the concrete will be paid for extra, at the unit price bid per cubic yard for miscellaneous concrete.

### 3.26 SETTING FIRE HYDRANTS

Fire hydrants shall be placed at the locations shown on the plans. Gate valves for fire hydrants shall be connected directly to the main by means of a "Locked Hydrant Tee". All other connections between the main and the fire hydrant shall be mechanical joint. Fittings shall be restrained by a "Locked Hydrant Adapter" whenever the fire hydrant is located close enough to the main to allow its use. Not less than four cubic feet of No.5 or No.57 stone shall be placed around the base of the hydrants, as shown in the Standard Detail 401.02. Before placing the hydrants, care shall be taken to see that all foreign material is removed from within the body. The stuffing boxes shall be tightened and the hydrant valve opened and closed to see that all parts are in first class working condition. All hydrant openings shall be kept capped, except when hydrant is being worked on.

When a fire hydrant has been constructed but is not yet in service, the Contractor shall provide and attach to the fire hydrant, flags or collars indicating that the fire hydrant is not in service. Said flags or collars shall remain on the fire hydrant until it is put into service. Whenever an existing fire hydrant is taken out of service, whether temporarily or permanently, it shall be equipped with a flag or collar indicating that it is not in service. The Contractor shall provide and install flags or collars as required and shall notify the

Fire Department whenever the operating status of any fire hydrant changes.

FIRE HYDRANTS SHALL NOT BE OPERATED WITH ANY TOOL EXCEPT A SPECIFICALLY DESIGNED FIRE HYDRANT WRENCH. If the Contractor observes any other contractor or person operating a fire hydrant with an unapproved fire hydrant wrench, he shall report that fact to the BLW immediately. It is the Contractors responsibility to insure that all new facilities are maintained in new condition until final completion of the project and acceptance by the BLW. Fire hydrants with damaged operating nuts shall not be accepted.

### 3.27 HIGHWAY AND RAILROAD CROSSINGS

Where the lines cross railroads and/or highways under the jurisdiction of the State Highway Department, or railroad, the Owner will obtain written permission from the controlling authority before any work can be done within the right-of-way. After the Owner notifies the Contractor that the permit or permits have been obtained, the Contractor shall coordinate his activities and construction procedure with the proper authority of the Railroad or the Highway Department and shall conform with the requirements thereof. The Contractor will be required to furnish a release from the said controlling authority before final acceptance of the work. The Contractor will be responsible for all damage and injuries to persons and property inflicted or caused by said work.

### 3.28 PLACING OF STEEL CASING PIPE

Steel Casing pipe shall be installed by the "Jack and Bore" procedure or the "Open-Cut" method. Steel casing pipe shall be installed at the specific locations called for on the plan sheets and the installation method shall be by the "Jack and Bore" procedure unless specifically stated to be installed by the "Open-Cut" method.

The "Jack and Bore" installation procedure shall be by the dry-bore method. The hole is to be mechanically bored and cased through the soil by a cutting head on a continuous auger mounted inside the casing pipe. The installation of the casing and boring of the hole shall be done simultaneously by jacking. Lengths of pipe are to be continuously welded the full circumference of the pipe diameter to the preceding section installed. Excavation material will be removed and placed at the top of the working pit. Backfill materials and methods of backfilling and tamping shall be as required under BACKFILLING. Bores, 250' and less in length, shall be installed by means of mechanical steering with water level guiding device. The casing shall be installed to within 3" +/- of the horizontal and vertical alignment shown on the Contract Drawings. Bores, greater than 250' in length, shall be installed by means of a laser-guided borehead with hydraulic steering. The bores shall be installed to within 3" +/- of the horizontal and vertical alignment shown on the Contract Drawings.

The "Open-Cut" method consists simply of excavating the trench along the pipeline route and placing the steel casing in the trench. Special care shall be taken not to damage any existing utilities as the sections of casing are maneuvered into the open trench. Lengths of pipe are to be continuously welded the full circumference of the pipe diameter to the adjacent sections. Backfill materials and methods of backfilling and tamping shall be as required under BACKFILLING.

Casing insulators shall be used while installing the water main inside the casing. Insulators shall be located within 2' of each end of the casing and spaced no more than 10' apart within the casing. After the water main is installed in the casing, a check shall be made to ensure that the carrier pipe is not touching the casing at any point. The ends of the casing pipe shall be sealed with a three course mortared brick wall, one course of which shall be erected inside the casing.

All bores shown shall be installed at the locations shown. The Contractor is required to examine the soil exploration information provided as an appendix to these Contract Documents. Prior to installation of the steel casing pipe, the contractor shall dig exploratory test holes to determine any soil condition different than shown on Contract Drawings or indicated by the soil exploration information. Payment for this work and all exploration work shall be included in price bid per linear foot of steel casing pipe.

In the event of a changed soil condition, the Engineer shall be notified.

### 3.29 BORE PITS

Bore pits for cased bores and uncased bores shall be constructed as to avoid conflicts with the existing utilities and remain in the limits of the construction area. The contractor shall take necessary precautions in order to insure the pit meets the latest requirements under the Cobb County Trench Safety Ordinance and O.S.H.A. requirements imposed on such work.

### 3.30 REMOVE & DISPOSE OF EXISTING APPURTENANCES

Where called for on the plans, all existing above ground appurtenances shall be removed and disposed of by the contractor. The area where these appurtenances are removed shall be regraded and grassed to match the existing landscaping.

### 3.31 REMOVING AND REPLACING PAVEMENT

#### 3.31.1 GENERAL

Removing and replacing pavement bituminous or concrete shall consist of removing the type of pavement and base encountered and replacing same as shown on the detailed drawings. Pavement shall be removed only as necessary to install water main.

#### 3.31.2 SUBGRADE

The trench shall be backfilled in layers not more than 6" thick and shall be thoroughly compacted with mechanical tamps. No base course shall be placed on loose earth or dusty material.

#### 3.31.3 BITUMINOUS PAVEMENT

Bituminous pavement shall be replaced with concrete base as shown on drawings and 2" of asphaltic concrete topping. Edges of cut pavement saw cut

and shall be neatly squared off. Then the base and edges shall be primed with a tack coat of AC15 or equal, applied at the rate of 0.25 gallons per square yard prior to placement of asphalt topping. Extreme care shall be executed to assure that the squared edges of existing pavement will not be broken or disturbed during rolling of 2" asphalt topping.

#### 3.31.4 MILLING AND PAVEMENT OVERLAY

The existing pavement shall be milled to a depth of 2" and a pavement overlay, 2" thick shall be placed. The Pavement Overlay shall be Type E asphalt as approved by the Georgia Department of Transportation.

#### 3.32 REMOVE & REPLACE CONCRETE CURB AND GUTTER

The Contractor shall remove only that curbing which would otherwise be damaged in the prosecution of his work within the limits of the pavement removal.

After the Contractor has completed his pipe laying and backfilling operations, the concrete curb and gutter shall be constructed monolithically on a prepared compacted subgrade, in conformity with the lines, grades and cross-section of the existing curbing and in accordance with these specifications.

Concrete materials, placement and protection shall be in accordance with ACI 318 specifications.

The forms, except the divider plates or templates between each ten (10) foot section, may be of wood or metal. The divider plates or templates shall be of metal. Forms shall be of approved sections and shall have a flat surface on top. Forms shall present a smooth surface, sufficiently thick and braced to withstand the weight of the concrete without bulging or becoming displaced. Special care shall be exercised to keep metal forms free from rust, grease or other foreign matter, which would discolor the concrete. Metal templates or dividing plates shall be of sufficient thickness and of such design as to hold the forms rigidly in place and to produce a smooth vertical joint after the plates are removed. They shall be of the full dimensions shown on the plans for curb, gutter or combinations of curb and gutter.

Concrete curb and gutter shall be constructed in sections having uniform lengths of ten (10) feet. The length of these sections may be reduced where necessary for closures, but no section less than six (6) feet will be permitted. These sections shall be separated by sheet steel templates set perpendicular to the face and top of the curbing. These templates shall be one-eighth (1/8) of an inch in thickness of the widths of the gutter and not less than two (2) inches longer than the depth of each respective type. The templates shall be set carefully during the placing of concrete and allowed to remain in place wherever possible until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in place. The vertical face and top of the curb shall be floated smooth and the edge of the face shall be rounded to a radius of three-quarters (3/4) of an inch while the concrete is still soft. The forms on the face of the gutter and curb shall be removed as soon as possible and at the surface of the curb floated with a wooden float to a smooth and even surface finish.

Immediately after the removal of the forms, the ends of the transverse joints at the edge shall be carefully opened for the entire depth of the cross section. Expansion joints shall be formed of premolded joint filler of the specified thickness, and shall be placed in line with the expansion joints in the adjoining pavement or gutter and at other locations designated on the plans. All joint filler shall be cut to full depth, width and length of construction. Any expansion joint material protruding after the concrete is finished shall be trimmed as directed. Where curb and gutter is constructed upon a street without paving, the distance between expansion joints shall not exceed forty (40) feet.

After the concrete has set sufficiently, the space behind the curb shall be refilled to the required elevation with material, which shall be compacted by tamping until firm and solid.

Where concrete curb and gutter is to be located along the edge of existing pavement, the following procedure shall apply. A uniform alignment shall be established by string line. A cut line will be marked along the pavement to give a uniform cut width of 24 inches, and the pavement will be sawed and then removed to a depth of six inches. The cut edge will be used for the front form of the curb and gutter except in locations where the edge of pavement deviates from face of curb by six inches or more in which case a front form will be used. The space will later be filled with concrete to a depth of two inches below the surface and finished with a two-inch thick layer of asphalt.

In cases where new replaced curb is joined to old curb, the old curb shall be squared off to provide a straight construction joint.

### 3.33 REMOVE & REPLACE CONCRETE SIDEWALK

Debris from sidewalks removed shall be collected and hauled away and disposed of by the Contractor in an approved disposal area. Sidewalks shall be replaced with Portland Cement Concrete of not less than 3,000 p.s.i. compressive strength at 28 days of age. Sidewalks shall be replaced to the original width and thickness or a minimum of 4" thick. The sidewalks shall have a broom finish. All instructions in Placing of Concrete in these specifications shall be adhered to.

### 3.34 REMOVE & REPLACE CULVERTS (ALL SIZES & TYPES)

When culverts are encountered during the construction of the pipeline, the said culvert shall be removed and then replaced upon installation of the pipeline. If the culvert, in the opinion of the engineer, is damaged beyond use the contractor shall be responsible for replacing new culvert pipe to match the existing pipe.

### 3.35 REPLACING GRAVEL DRIVEWAYS

Gravel driveways will be replaced at locations shown on the plans. Gravel shall be GAB stone and shall be placed 6" deep

### 3.36 REPAIR OF SEPTIC TANK DRAIN FIELDS

If the contractor encounters an existing septic tank drain field during installation of the proposed water main, he shall immediately notify the Cobb County Health Department

and acquire a permit to repair the drain line in accordance with Health Department regulations. A new drain field line will be installed as necessary a minimum of ten feet away from the proposed water main.

### 3.37 PAINTING TRAFFIC STRIPE

The painting of traffic stripes shall comply with the requirements of Georgia DOT Specification Section 652, latest revision.

### 3.38 INSTALLING EROSION CONTROL MATS

Erosion control mats for slopes and waterways shall be installed in accordance with detailed instructions on the Contract Drawings and manufacturer's instructions.

### 3.39 GRASSING

All areas outside structures and along pipelines where the earth is disturbed shall be grassed. After the soil has been properly prepared, the seed shall be planted. After the seeds have been planted, the moisture content of the soil shall be maintained at the optimum amount to insure germination of the seed and growth of the grass.

Immediately after the initial watering of seeded areas, the contractor shall apply a mat of hay or rye, wheat or oat straw over the area at a uniform rate of not less than 1-1/2 ton of mat to the acre. The minimum depth of the straw shall be 2 inches and the maximum depth 3 inches. After placing mat or hay or straw, emulsified asphalt shall be sprayed over the mat at a uniform rate of 0.15 gallon per square yard. After the grass has shown a satisfactory growth (approximately 30 days after planting), nitrate of soda shall be applied at a uniform rate of 100 pounds per acre, followed by sufficient water to dissolve the fertilizer.

The Contractor shall do all maintenance work necessary to keep all planted areas in satisfactory condition until the work is finally accepted. This shall include mowing, repairing washes that occur, reseeding, and water as required to produce a healthy and growing stand of grass. Mowing will be required to remove tall and obnoxious weeds before they go to seed.

It is the intent of these specifications to produce a stand of grass that is alive and growing, without any bare spots larger than one square foot. The Contractor shall repeat all work, including plowing, fertilizing, watering, and seeding as necessary to produce a satisfactory stand.

**\*\*END OF SECTION\*\***

SECTION 02 32 13  
SUBSURFACE CONDITIONS

PART 1 - GENERAL

1.1 GENERAL

The following soils investigation report has been prepared for the site:

1. "Report of Subsurface Exploration and Geotechnical Engineering Evaluation – Highway 41 Water Main – Phase IV"  
Dated: May 22, 2013 By: GEO-HYDRO Engineers, Inc.
2. "Report of Supplemental Subsurface Exploration and Geotechnical Engineering Evaluation – Tunnel Section - STA 52+55 to STA 86+00 - Highway 41 Water Main – Phase IV"  
Dated: December 9, 2013 By: GEO-HYDRO Engineers, Inc.
3. "Geotechnical Exploration Summary – Tunnel Section – STA 54+65 - Highway 41 Water Main – Phase IV".  
Dated: February 18, 2015 By: GEO-HYDRO Engineers, Inc.

PART 2 - PRODUCTS

2.1 REPORT

This soils investigation report is available from the Engineer.

**\*\*END OF SECTION\*\***