Date: July 5, 2001
First Use Date 2001 Specifications: November 1, 2002
Revised :November 5, 2007
Revised: July 29, 2009
Revised: September 28, 2009

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

Section 300—General Specifications for Base and Subbase Courses

Delete Subsection 300.3.02.H and substitute the following:

H. Fine Grading Equipment

An approved fine grading machine is required for finishing the base and subbase material supporting Portland cement concrete pavement or hot mix asphaltic concrete pavement. Ensure fine grader:

- Is self-propelled and track driven.
- Is capable of trimming and finishing the base and subbase to the specified tolerances utilizing a rotating cutter head in front of a strike-off screed.
- Spans at least one lane width and is controlled automatically by direct contact with a string line or a combination of string line and existing pavement as appropriate.
- Is capable of trimming and finishing base and subbase to the specified tolerances.

Furnish, place, and maintain the necessary string lines to provide continuous line and grade reference to the fine grader control system. GPS controlled equipment can be used in lieu of string lines.

For Graded Aggregate Base construction, a motor grader equipped with GPS controlled equipment can be used as an option for fine grading.

GPS controlled Equipment will include but is not limited to:

1. Ability to read electronic files containing Department supplied data used to design the project.

2. Fixed or movable base station setup on the project to serve as a point of reference for the project. As the project progresses, the movable base station shall be moved for proper system function. If the base station is at a fixed location, radio repeaters will be utilized to ensure the signals from the base station are received throughout the project.

3. A GPS sensor mounted atop a mast affixed to the cutting blade. The masts will be arranged in a dual mast setup with a mast on each end of the blade attachment or in a lone mast setup. The sensor will be able to receive signals from the base station and/or a laser transmitter.

4. A blade position sensor with the ability to detect blade attitude and elevation of the cutting blade and relay this information to the operator. Blade attitude is defined as the orientation of the blade with respect to the three spatial axes in relation to a reference plane.

5. An operator-visible display allowing the operator to visually receive all necessary data in real-time from the GPS system and the cutting blade to properly construct the section to grade. The display will also reflect any changes made by the operator to any operation of the cutting blade.

6. If conformity to the cross sections with the prior listed equipment is unsatisfactory, provide a laser transmitter placed no farther than 800 feet (244 m) from the fine grading equipment. Projects having work progressing at different work sites more than 800 feet (244 m) apart necessitate the use of more than one laser transmitter to ensure accuracy. Select a location for the laser transmitter having a change in elevation of 25 feet (7.62 m) or less from the laser transmitter to the sensor mounted on the cutting blade. If project geography necessitates the use of more than one laser transmitter, the setup of the transmitters will be set to ensure the elevation difference between two consecutive transmitters in an array is not more than 25 feet (7.62 m); and this array cannot exceed a total change in elevation of 100 feet (30.5 m).

May 24, 2006
Revised: September 21, 2006
Revised: November 30, 2010
Revised: May 16, 2012
Revised: June 12, 2012
Revised: June 14, 2012

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION
P. I. No.

Section 432—Mill Asphaltic Concrete Pavement

Retain Section 432 and add the following:

Section 432—Mill Asphaltic Concrete Pavement (Micro-Mill)

432.1 General Description

This work includes micro-milling of existing asphaltic concrete pavement to remove wheel ruts and other surface irregularities, restore proper grade and/or transverse slope of pavement as indicated in the Plans and as directed by the Engineer. The micro-milled surface shall provide a texture suitable for use as a temporary riding surface or an immediate overlay with OGFC or PEM with no further treatment or overlays. The use of the micro-milled pavement as a temporary riding surface shall be a maximum of three (3) days, excepting rain event days where construction is not permitted. Perform the work according to these Specifications and Plan details.

B. Referenced Documents

GDT 126

432.3 Construction Requirements

432.3.02 Equipment

C. Micro-milling Equipment

Use power-driven, self-propelled micro-milling equipment possessing the size and shape to allow traffic safe passage through areas adjacent to the work. Also, ensure the micro milling equipment will be:

- Equipped with a cutting mandrel with carbide or equivalent tipped cutting teeth designed for micro-milling bituminous pavement full lane width to close tolerances for mainline travel way. None full lane width micro-milling heads may be used for non mainline travel way.
- Equipped with grade and slope controls operating from a string line or ski and based on mechanical or sonic operation
- Capable of removing pavement to an accuracy of 1/16 in (1.6 mm)
- Furnished with a lighting system for night work, as necessary
- Provided with conveyors capable of side, rear, or front loading to transfer the milled material from the roadway to a truck

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432.3.05 Construction

B. Micro-milling Operation

Follow the Plans to micro-mill the designated areas and depths including bridge decks, shoulders, and ramps, as required. Ensure the following requirements are met:

1. Prior to commencement of the work, construct a test section that is 1000 feet in length with a uniformly textured surface and cross section as approved by the Engineer.
   - The final pavement surface shall have a transverse pattern of 0.2 in. (5 mm) center to center of each strike area. The target difference between the ridge and valley (RVD) measurement of the mat surface shall not exceed 1/16 in. (1.6 mm).
   - Surface acceptance testing will be performed using the Laser Road Profiler in accordance with GDT-126. Ensure the measured indices meet a target of 825 mm/km in the test section.
   - Work shall be halted and the contractor shall submit a written plan of action detailing what steps will be taken to improve operations if any of these requirements are exceeded in the test section. If approved by the Engineer, the contractor will construct another 1000 ft test section. This test section shall be located in a different area than the initial section using the approved corrective action. This designated section shall be micro-milled to conform to the same requirements as those required in the initial test section. The contractor shall not be allowed to start continual micro-milling until an acceptable test section is obtained.
2. Ensure micro-milling methods produce a uniform finished surface and maintain a constant cross slope between extremities in each lane.
3. Provide positive drainage to prevent water accumulation on the micro-milled pavement, as shown on the Plans or directed by the Engineer.
4. Bevel back the longitudinal vertical edges greater than 2 in (50 mm) produced by the removal process and left exposed to traffic. Bevel the vertical edges back at least 3 in for each 2 in (75 mm for each 50 mm) of material removed. Use an attached mold board or other approved method.
5. Taper the transverse edges 10 ft (3 m) to avoid creating a traffic hazard and to produce a smooth surface when removing material at ramp areas and ends of milled sections.
6. Protect with a temporary asphaltic concrete tie-in (paper joint) vertical edges at other areas such as bridge approach slabs, drainage structures, and utility appurtenances greater than 1/2 in areas left open to transversing vehicles. Place the temporary tie-in at taper rate of at least 6 to 1 horizontal to vertical distance.
7. Remove dust, residue, and loose milled material from the micro-milled surface. Do not allow traffic on the milled surface and do not place asphaltic concrete on the milled surface until removal is complete.

432.3.06 Quality Acceptance

Ensure the micro-milling operation produces a uniform pavement texture true to line, grade, and cross section.

Micro-mill additional depth to eliminate excessive scabbing of the in place material as directed by the Engineer.

Micro-milled pavement surface acceptance testing will be performed using the Laser Road Profiler method in GDT 126. Micro-milled pavement will be evaluated on individual test sections, normally 0.50 mile (0.50km) long. Ensure indices meet target 825 mm/km and not exceed the correction index of 900 mm/km.

Micro-milled pavement surfaces are subject to visual and straightedge inspections. Ensure a 10 ft. straightedge is kept at the micro-milling operation to measure surface irregularities of the milled pavement surface. Any areas exceeding 1/8 in (3.2 mm) between the ridge and valley of the mat surface or fail to meet pavement surface acceptance testing using the Laser Road Profiler shall require the underlying layer be removed and replaced with material as directed by the Engineer at no additional cost to the Department. All corrective work shall be performed in a minimum 1000 ft section.

Ensure the cross slope is uniform and no depressions or slope misalignments greater than 1/4 in per 12 ft (6 mm in 3.6 m) exist when the slope is tested with a straightedge placed perpendicular to the center line.

432.4 Measurement

Micro-milling existing asphaltic concrete pavement is measured by the square yard (meter) as described in Specification Section 109 Measurement and Payment, Subsection 109.01, “Measurement and Quantities.”

432.5 Payment

Micro-milling asphaltic concrete pavement, measured as specified, will be paid for at the Contract Unit Price bid per square yard (meter). No adjustment in the unit price for this item or other items will be considered for variations in the amount of reclaimed asphaltic pavement (RAP) actually recovered.

Payment is full compensation for furnishing equipment, micro-milling, hauling, stockpiling milled material, and satisfactorily performing the work.

The reclaimed asphaltic pavement (RAP) will become the Contractor's property unless otherwise specified.

Payment will be made under:

Item No. 432	Micro-mill asphaltic concrete pavement, variable depth	Per square yard (meter)

Department of Transportation

State of Georgia

Special Provision

Section 500—Concrete Structures

Add the following to 500.1.03.A:

The Contractor is responsible for all concrete mix designs. Submit a mix design for approval to the Office of Materials and Research. Include the sources, actual quantity of each ingredient, design slump, design air and laboratory results that demonstrate the ability of the design to attain the required compressive strength at 28 days.

Prepare and test at least 8 cylinders according to ASTM C192 and AASHTO T22 to ensure that the demonstrated laboratory compressive strength at 28 days exceeds the minimum acceptance strength (X). Make the specimens from two or more separate batches with an equal number of cylinders made from each batch. The minimum acceptance strength is:

$$X = f'c + 500 \text{ psi } (X = f'c + 3.4 \text{ MPa})$$

Where, f'c is the required minimum compressive strength at 28 days for Class D concrete as shown in Table 1–Concrete Mix Table.

Add the following to Table 1—Concrete Mix Table:

Table 1—Concrete Mix Table

English								
Class of Concrete	**(2) Coarse Aggregate Size No.**	**(1 & 6) Minimum Cement Factor lbs/yd^3**	**Max Water/ Cement Ratio lbs/lbs**	**(5) Slump Acceptance Limits (in) Lower - Upper**		**(3 & 7) Entrained Air Acceptance Limits (%) Lower - Upper**		**Minimum Compressive Strength at 28 days (psi)**
Class D	**57,67**	**650**	**0.445**	**2**	**4**	**3.5**	**7.0**	**4000**
Metric								
Class of Concrete	**(2) Coarse Aggregate Size No.**	**(1 & 6) Minimum Cement Factor kg/m^3**	**Max Water/ Cement Ratio kg/kg**	**(5) Slump Acceptance Limits (mm) Lower - Upper**		**(3 & 7) Entrained Air Acceptance Limits (%) Lower - Upper**		**Minimum Compressive Strength at 28 days (MPa)**
Class D	**57,67**	**386**	**0.445**	**50**	**100**	**3.5**	**7.0**	**28**

Delete Subsection 500.3.04.F.1.b and add the following:

b. Class AA—Bridge substructure concrete or precast concrete as called for on the Plans

Add the following to Subsection 500.3.04.F.1:

f. Class D—Bridge superstructure concrete or as called for on the Plans

Georgia Department of Transportation

State of Georgia

Special Provision

Section 500—Concrete Structures

Delete Subsection 500.1 and substitute the following:

This work consists of manufacturing and using High Performance Portland cement concrete to construct precast-prestressed concrete bridge members as shown in the plans and using normal weight Portland cement concrete to construct structures as shown in the Plans.

Add the following to Subsection 500.1.02.A:

Section 831—Admixtures

Add the following to Subsection 500.1.02.B:

AASHTO T 277

Add the following to Subsection 500.1.03.A:

High Performance Concrete Mix Designs

The Fabricator is responsible for all concrete mix designs. Ensure that concrete mixes contain enough cement to produce workability within the water-cement ratio specified in Table 1A—High Performance Concrete Mix Table, below.

Submit a mix design for approval to the Office of Materials and Research. Include the sources and actual quantity of each ingredient and laboratory results that demonstrate the ability of the design to attain both the required compressive strength and chloride permeability at 56 days.

Include laboratory compressive strength test results of at least eight test cylinders prepared and cured according to AASHTO T 126. Ensure these test cylinders are made from two or more separate batches with an equal number of cylinders made from each batch.

Also include laboratory chloride permeability test results of at least two test specimens prepared and tested according to AASHTO T 277. Ensure these test specimens are made from two or more separate batches with an equal number of specimens made from each batch.

Table 1A—High Performance Concrete Mix Table

English									
Class of Concrete	**Coarse Aggregate Size No.**	**(1) Minimum Cement Factor (lbs/yd^3)**	**Maximum Water/ Cement ratio (lbs/lbs)**	**(2) Slump Acceptance Limits (in) Lower-Upper**		**Entrained Air Acceptance Limits (%) Lower-Upper**		**(3) Minimum Compressive Strength at 56 days (psi)**	**Maximum Chloride Permeability at 56 days (Coulombs)**
"AAA HPC"	67	650	.330	2	7	3.5	6.5	Beams – As shown on the Plans Piling – 5000	Beams – 3,000 Piling – 2,000
Metric									
Class of Concrete	**Coarse Aggregate Size No.**	**(1) Minimum Cement Factor (kg/m^3)**	**Maximum Water/ Cement ratio (kg/kg)**	**(2) Slump acceptance Limits (mm) Lower-Upper**		**Entrained Air Acceptance Limits (%) Lower-Upper**		**(3) Minimum Compressive Strength at 56 days (MPa)**	**Maximum Chloride Permeability At 56 days (Coulombs)**
"AAA HPC"	67	386	.330	50	180	3.5	6.5	Beams – As shown on the Plans Piling – 35	Beams – 3,000 Piling – 2,000

1. Determine the slump acceptance after the addition of high-range water reducer.

2. Determine the minimum compressive strength at 56 days using 4 in. diameter x 8 in. high (100 mm x 200 mm) cylinders.

Add the following to Subsection 500.2 Table 3:

Fly Ash	831.2.03.A.1
Silica Fume	831.2.03.A.4

Add the following note to Subsection 500.2 Table 3:

4. Use Type I or III Portland cement in High Performance concrete. Do not use air-entraining cement.

Add the following to Subsection 500.3.04.D.4:

f. For High Performance concrete, fly ash may be used as an additive at an addition rate not to exceed 15% of the cement by weight.

Add the following to Subsection 500.3.04.D:

6. Silica Fume

   Silica Fume may be used as an additive at an addition rate not to exceed 10% of the cement by weight.

September 11, 2013

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA
SPECIAL PROVISION

Section 500—Concrete Structures

Add the following to Subsection 500.1.02:

B. Referenced Documents

"Guide to Mass Concrete", ACI 207.1R-05.

"Report on Thermal and Volume Change Effects on Cracking of Mass Concrete", ACI 207.2R-07.

"Cooling and Insulating Systems for Mass Concrete", ACI 207.4R-05.

"Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete", ACI 211.1-91

"Control of Cracking Concrete Structures", ACI 224R-01.

"Specification of Structural Concrete", Section 8, ACI 301-10.

"Compressive Strength of Cylindrical Concrete Specimens", AASHTO T 22-10

"Making and Curing Concrete Test Specimens in the Laboratory", ASTM C192

Add the following to Subsection 500.3.05:

AM. Mass Concrete

Mass concrete is defined as "Any large volume of concrete with dimensions large enough to require that measures be taken to cope with the generation of heat and attendant volume change to minimize cracking". Any concrete element with a least dimension greater than 5ft (or greater than 6 ft diameter for a drilled shaft) shall be designated as mass concrete and will use this specification. The introduction of a construction joint at a dimension less than 5 ft does not ensure that the maximum temperature attained by or the differential temperature in concrete is adequately controlled. Proposals for large volume concrete shall thus be evaluated based on the heat development and a Thermal Control Plan.

a. Temperature Specifications for Mass Concrete

Mass concrete shall conform to the concrete acceptance criteria and the following temperature requirements to prevent delayed ettringite formation (DEF) and thermally induced stress cracks:

1. The maximum allowable internal temperature of mass concrete meeting the requirements of Subsection 500.3.05.AM.b.1, shall not exceed 158 °F.

2. The maximum temperature differential between interior and exterior portions of the designated mass concrete element shall not exceed 35 °F.

3. The maximum temperature of the concrete when delivered and prior to placement shall be 85 °F.

b. Materials Selection and Mix Design Development

Materials used for mass concrete shall conform to the provisions in Section 500-Concrete Structures of GDOT *Standard Specifications-Construction of Transportation Systems* and the following requirements. When in conflict, materials shall conform to the special provisions below rather than those in Section 500.

1. Use Class F fly ash (no Class C fly ash is allowed), granulated iron blast-furnace slag or other pozzolans, if approved by the Department in all mass concrete. Slag may comprise no more than 75% by mass of total cementitious and pozzolanous materials. Class F fly ash may comprise no more than 40% by mass of total cementitious and pozzolanous materials. When a combination of multiple different pozzolans is used, the total amount may be no more than 75% by mass of total cementitious and pozzolanous materials.

2. High-early-strength (ASTM C150 Type III or ASTM C1157 HE) cement, metakaolin, silica fume calcium chloride and accelerating type admixtures shall not be used unless an adiabatic temperature study is completed showing temperature rise significantly less than that of plain unmodified concrete.

3. A retarding admixture, pretested with the job materials under job conditions, may be permitted to prevent cold joints due to the quantity of concrete placed, as approved by the Engineer.

4. Coarse aggregate larger than #5 stone maximum size aggregate is permitted to be used for mass concrete, if approved by the Engineer.

5. Other materials and/or mix designs may be proposed to the Engineer for approval, with documentation that the proposed mix designs meet temperature specifications from Subsection 500.3.05.AM.a for mass concrete.

6. Laboratory-designed mix proportions of materials are permitted for commonly used combinations of materials. Request these mixes in writing from the State Materials Engineer specifying the class of concrete and the source of ingredients.

7. Degree of Alkali-Silica Reactivity (ASR) of either fine or coarse aggregate is determined by testing the aggregates in ASTM C1260, or ASTM C1567 (either expansion shall be less than 0.10% after 14 days immersion). Unless the results of petrography indicate a significant change in the composition of materials in quarries, ASTM 1293 (expansion <0.04% at 1 year) is not required to be conducted, before a

mix design can be approved by the Engineer. Alternatively obtain low ARS risk aggregate materials from certified suppliers.

8. The mixture will be capable of demonstrating a laboratory compressive strength at 28 days meeting the requirements of Table 1 – Concrete Mix Table, *Subsection 500.1.03.A.* Compressive strength will be determined based upon result of six cylinders prepared and tested in accordance with AASHTO T 22 and ASTM C192.

c. Thermal Control Plan

At least 30 calendar days prior to placing any concrete defined as mass concrete, the contractor shall submit to the Engineer for approval a Thermal Control Plan (TCP). The TCP shall show complete analysis of the anticipated thermal developments in the mass concrete elements for all expected project temperature ranges using the proposed mix design, casting procedures and materials. A primary focus of the TCP is actions to take when any of the temperature controls noted in Subsection 500.3.05.AM are exceeded or are anticipated to be exceeded. As a minimum, the TCP shall include details about the following:

1. Concrete mix design showing composition, proportions, and sources for all components.
2. Proposed methods to control concrete temperature at time of placement, such as pre-cooling of raw materials or concrete.
3. Duration and method of curing.
4. Calculations of maximum concrete temperatures for the range of expected air, water (for underwater construction) and concrete temperatures.
5. Proposed methods to control maximum temperature during curing. A mechanical cooling system may be used to control the internal temperature of mass concrete during curing but shall be designed in conformance with the Thermal Control Plan. If a mechanical cooling system is used, the plans for the cooling system operation and final grouting after cooling shall be submitted to the Engineer for approval.
6. When the maximum concrete temperature nears 140 °F, notify the Engineer and take corrective measures immediately to retard further increase in the temperature to limit it to the 158 °F maximum. Utilize the mechanical cooling system, if installed, to lower the overall temperature. Other active measures may include, but not limited to for any further pours: chilled water for mixing, precooling aggregate stockpiles, ice for mixing water, nitrogen gas, and shade for aggregate stockpiles. Cease placement of concrete until the maximum temperature has been lowered.
7. Proposed methods to control temperature differentials during curing that could include insulation for the forms and exposed portions of concrete. Contractor must take actions that prevent the exterior surfaces of the concrete from getting too cool, too quickly such as using insulation or heater or by preventing the core from getting too hot.

8. When the internal concrete temperature differential between interior and exterior concrete nears 30°F, notify the Engineer and take corrective measures immediately to retard further increase in the temperature differential to limit it to the 35°F maximum. Utilize the mechanical cooling system, if being use, to lower the internal temperature. Other active measures may include, but not limited to: chilled water for mixing, precooling aggregate stockpiles, ice for mixing water, nitrogen gas, and shade for aggregate stockpiles. Cease placement of concrete until the temperature differential has been lowered.

9. Calculations of maximum temperature gradients within each concrete element during curing. Calculations shall include maximum possible temperature induced tensile stress in the concrete in addition to tensile stresses at 1 day, 3 days, 7 days, 28 days, and 56 days after placement. The thermal calculation model and/or computational software shall be submitted to the Engineer for approval.

10. Temperature monitoring and recording system, that shall consist of temperature sensors connected to a data acquisition system. The temperature sensor types and locations shall be specified.

11. Results of strength tests of sample cylinders. The concrete shall attain the specified strength at an age (28 or 56 days) as specified by the Engineer. Match curing of concrete is required. Match curing shall be conducted according to temperature history obtained using thermocouples typically 4 inches from surface and at the centroid of the concrete pour. The depth of the thermocouple may need to be established by the depth of rebar or other anchoring structure (See Subsection 500.3.05.AM.d.3 and Subsection 500.3.05.AM.d.5).

12. For all mass concrete construction, the TCP shall be developed by a Professional Engineer, licensed in the State of Georgia, who shall be competent in the modeling, design, and temperature control of mass concrete with at least three mass concrete projects experience that can be verified by the Department.

Place no concrete until the mass concrete mix design and the proposed TCP is reviewed and approved by the Engineer. If concrete design mixture is changed, the TCP must be updated and approved by the Engineer.

d. Temperature Monitoring and Recording System

1. Install within the concrete placed in each mass pour and in the surrounding environment of the concrete, temperature sensing devices (thermocouples) of a type approved by and at locations based on the plan approved by the Engineer.

2. The sensing system will contain as a minimum two independent sets of sensing devices in order to assure readings if one of the systems fail. The sensing devices shall be accurate to within 2°F range.

3. Thermocouples shall be placed at the centroid of the pour, or wherever the point of expected maximum temperature is anticipated. Additional thermocouples shall be placed on the exterior to monitor the maximum temperature differential. Ensure the thermocouples are placed at a depth of 2 to 6 inches below the surface.

4. The temperature monitoring and recording system for mass concrete shall consist of temperature sensors connected to a data acquisition system capable of printing, storing, and downloading data to a computer. Data shall be printed and submitted to the Engineer daily with a copy sent to Office of Materials and Testing.
5. Two independent sets of sensing devices shall be placed at each of the following locations and readings to be taken hourly: (1) center of the mass pour; (2) midpoint of the side which is the shortest distance from the center; (3) midpoint of the top surface; (4) midpoint of the bottom surface; and (5) corner of the mass pour which is furthest distance from the center. Ensure the thermocouples are placed at a depth of 2 to 6 inches below the surface.

e. Placing and Curing Mass Concrete

When placing and curing mass concrete do the following:

1. Maintain a temperature differential of 35 °F or less between the interior and exterior portions of the designated mass elements.
2. Monitor and maintain records of the concrete temperature, beginning with casting and continuing until the maximum temperature is reached and begins decreasing to a differential of no more than 35°F from the mean annual ambient temperature of the surrounding environment, for three consecutive days.
3. The contractor shall suggest consolidation techniques based on the placement technique to be used for mass concrete. The consolidation technique shall be reviewed and approved by the Engineer before start of placement of mass concrete. Slump tests or slump-flow (ASTM C 1611) tests, as applicable, shall be used to provide quality control from batch to batch.
4. Maintain a minimum concrete placement rate of 30 cubic yards per hour or as designated on the plans or in the Special Provisions. Any requested change from this placement rate is to be approved by the Engineer.

f. Acceptance

Mass concrete shall conform to the concrete acceptance criteria and the temperature requirements as stated earlier to prevent delayed ettringite formation (DEF) and thermally induced stress cracks.

If the Contractor fails to conform to any of the above temperature requirements in any one pour, any additional mass concrete pours will cease. The Engineer may, at its sole discretion, direct that the concrete be removed or otherwise mitigated, at no cost to the Department. The contractor shall revise the Thermal Control Plan and design calculations to correct the problem and resubmit the revised Thermal Control Plan. Mass concrete placement shall not begin until the Engineer has approved the revised Thermal Control Plan. No extension of time or compensation will be made for any rejected mass concrete element or revisions of the Thermal Control Plan.

Office of Materials and Testing

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA
SPECIAL PROVISION

Section 511 – Reinforcement Steel

Add the following to 511.2 Materials, B. Fabrication:

2. **Reinforcement Steel Couplers.** When couplers are indicated on the Plans, use mechanical butt splices from an approved source listed on QPL 93.

   Provide mechanical butt splices which develop a minimum of 125% of the guaranteed yield strength of the reinforcing steel to be spliced. Limit the total slip of the reinforcing bars within the splice sleeve after loading to 30 kips per square inch (207 MPa) and relaxing to 3 kips per square inch (21 MPa) to no more than the following, as measured between gauge points clear of the splice sleeve: 0.010 of an inch (.25mm) for reinforcing bars no. 14 (43) or smaller, or 0.030 of an inch (.76mm) for reinforcing bars no. 18 (57).

   Prior to installation on GDOT projects, the contractor is required to submit job-control samples for testing to the Office of Materials and Testing. This is to ensure that the installer is qualified to construct the units. Make test specimens in the presence of the Engineer or his authorized representative using reinforcing steel consigned for the work. A test specimen consists of a splice made at the job site to connect two 24 inch (600mm) or longer bars using the same splice materials, position, location, and equipment, and following the same procedures to be used to make splices in the work. Prior to incorporating couplers into the work, make and test three specimens that meet the above criteria.

   Perform all testing required above by the Office of Materials and Testing or at a testing laboratory approved by the Department.

   If threaded couplers are used, equip them with approved devices which will prevent rotation after installation.

   After installation, clean all couplers with a power wire brush or by other approved methods and recoat the couplers with a material prepared and recommended by the coating manufacturer.

   Install the couplers in strict accordance with the manufacturer's instructions and as approved by the Engineer.

   All costs for the couplers, test samples (including reinforcing steel for tests) and testing of couplers shall be included in the costs of reinforcing steel.

Date: September 1, 2006

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

Project No:
P.I. No.

SECTION 519 – FAST TRACK PORTLAND CEMENT CONCRETE OVERLAYS WITH HYDRODEMOLITION

519.1 General Description

This work consists of the construction of a Portland Cement concrete overlay of an existing concrete bridge deck and includes the furnishing of all material, labor and equipment necessary to prepare and finish the work in accordance with these Specifications and Plan details.

519.1.01 Definitions

General Provisions 101 through 150.

519.1.02 Related References

A. Related Specifications

Section 107

Section 449

Section 500

Section 510

Section 528

Section 941

B. Related Documents

AASHTO M-171

AASHTO T-126

QPL 10

QPL 86

519.1.03 Submittals

Submit a mix design for approval, including the actual quantity of each ingredient and laboratory designs which demonstrates the ability of this design to attain a compressive strength of 4000 psi (28 MPa) at 24 hours. Determined the acceptable strengths by at least eight laboratory compressive test specimens prepared and cured in accordance with AASHTO T-126. Make the specimens from two or more separate batches with an equal number of cylinders made from each batch.

519.2 Materials

Meet the requirements of the Standard Specifications for all materials.

Concrete Mix Requirements	
Materials	**Requirement**
Type I[1] or Type III Portland Cement, minimum	750 lbs/yd^3 (445 kg/m^3)
Coarse Aggregate Size No.	7
Water/Cement Ratio, maximum	0.43
Slump Limits (Jobsite), maximum	7 in. (180 mm)
Air Acceptance Limits (Jobsite)	3.5 to 7.5%
Admixture (Required)	Type F or G
Admixture[2] (Optional)	Type C
Compressive Strength (Jobsite) @ 24 hours, minimum	3000 psi (20 MPa)
Fibers[3]	3 lbs/yd^3 (1.8 kg/m^3)
1. An additional 10 percent cement is required when using Type I cement. 2. Do not use accelerators containing chlorides. 3. Use macro-synthetic fibers meeting the requirements of Section 941 of the Special Provisions. See QPL 86 for a list of approved suppliers.	

Temperature Limitations	
Concrete Placement Temperature (Range)	70-90 °F (21 – 32 °C)
Air Temperature (Range)	50-90 °F (10 – 32 °C)

Use concrete manufactured at plants that qualify as approved sources according to the Standard Operating Procedure for Ready Mix Concrete. See QPL 10 for a list of approved plants.

Manufacture concrete for Portland cement concrete overlays in accordance with Section 500 of the Standard Specifications.

519.2.01 Delivery, Storage and Handling

Store all materials to prevent damage from the elements and to insure the preservation of its quality and fitness for the work. Avoid contact with flame.

Inspect all stored materials, although accepted before storage, prior to their use in the work. Ensure that all stored materials meet the requirements of the Contract at the time of use.

Remove from the site of the work immediately, any material rejected because of failure to meet the required tests or rejected because of damage. Replace all removed material at no additional cost to the Department.

519.3 Construction Requirements

519.3.01 Personnel

General Provision 101 through 150.

519.3.02 Equipment

General Provisions 101 through 150.

1. The hydro-demolishing equipment consists of filtering and pumping units operating in conjunction with a remote-controlled robotics device.
2. The equipment operates at a noise level of less than 90 decibels at a distance of 66 ft. (20 m) from either the powerpac unit or the remote robot.
3. The equipment is capable of working 24 hours per day.

Provide an external water source for use in the hydro-demolition operations. Do not draw water from any waterway for use in construction. During the hydro-demolition operations, furnish protective platforms in accordance with Section 510 of the Georgia DOT Specifications to prevent material and debris from falling into the waterway or roadway. Furnish, install and maintain erosion control measures, approved by the Engineer, to contain and filter run-off from hydro-demolition operations. Prevent all debris, runoff or other materials from entering any waterway.

519.3.03 Preparation

A. Removal of Existing Concrete

Give the existing deck to be overlaid a machine preparation consisting of removal of the concrete to a minimum depth of ½ in. (12 mm) below the top mat of reinforcement or as shown in the Plans. Remove concrete by the use of high pressure water blasting equipment designed specifically for this purpose. This equipment is capable of removing deteriorated or non-deteriorated concrete, to depths specified on the Plans, and cleaning the existing reinforcing steel of all rust and corrosion products by use of high-velocity water jets acting under continuous automatic control.

B. Surface Preparation

1. Removal and Preparation of Overlay Area

Remove concrete to the limits shown on Plans and expose top mat of reinforcing steel. Remove deteriorated concrete and clean all rust and corrosive products from exposed reinforcing steel including oil, dirt, concrete fragments, laitance, loose scale and other coating of any character that would destroy or inhibit the bond with the new overlay concrete.

At the Contractors' option, mechanical scarifying equipment may be used to remove the concrete to within ½ in. (12 mm) of the reinforcing steel. Use a Rotomill-type mechanical scarifier designed specifically for deep scarifying of bridge decks to accomplish this operation. Ensure the scarifier produces a surface matching the slab cross-section, and that each pass of the machine matches the previous pass.

2. Existing Reinforcing Steel

Take all steps necessary to prevent cutting or otherwise damaging reinforcing steel, including any vertical stirrups, structural steel, and welded shear connectors projecting into the slab and designated to remain in place. If, in the opinion of the Engineer, any such bars or shear connectors are damaged during removal operations, replace with members of equal strength, size and spacing as the exisiting, to the satisfaction of the Engineer at no additional cost to the Department.

3. Areas Not Accesible to Hydro-demolition Equipment

Remove concrete in areas of the deck not accessible or otherwise convenient to hydro-demolition operations using conventional (jackhammer) removal methods. Perform such removal by power chipping or hand tools. Pneumatic hammers heavier than 15 lbs class (6.8 kg) [nominal], {(30 lbs) [13.6 kg] maximum} are not permitted. Do not operate pneumatic hammers and chipping tools at an angle exceeding 60 degrees relative to the surface of the deck slab.

4. Longitudinal Joints

Construct longitudinal joints between lanes vertical and at actual lane lines.

5. Removal of Debris

Remove concrete debris by hand or by mechanical means immediately following the hydro-demolition process to prevent the debris from re-setting or re-adhering to the surface or remaining sound concrete. Exercise care to avoid any damage to the remaining sound concrete, remove any debris allowed to re-settle or re-adhere to the surface of sound concrete.

519.3.04 Operations of Equipment:

A. General Operations

Provide qualified personnel to supervise and operate the hydro-demolition equipment. Avoid removal of sound concrete outside the limits and below the depth indicated on the plans.

Provide lighting as required to allow for the safe conduct of night time removal operations. Position lighting to avoid hazardous glare in the direction of oncoming traffic. Obtain the Engineer's approval for lighting placement and configuration. Store and maintain, on the job site, an inventory of common wear parts and replacement accessories for the equipment adequate to assure that routine maintenance tasks can be performed readily without undue project delay.

B. Run-off Water

Until its removal, contain all water runoff and residue caused by the hydro-demolition operation within the limits of the bridge deck. Submit to the Engineer for approval, a plan detailing containment and removal of the run-off water and slurry prior to beginning work. If satisfactory containment and removal of the runoff water or slurry is not being accomplished,

discontinue operations until adequate containment and disposal methods are approved and employed during removal operations to the satisfaction of the Engineer.

Provide for the disposal of runoff water and residue generated by the hydro-demolition operation. Obtain any required permits and comply with applicable regulations concerning such water and residue disposal. Make provision for the safe handling of runoff water insofar as it may constitute a hazard on the adjacent or underlying traveled roadway surface. Repair all existing slopes and berm areas damaged by scouring water jet, runoff water, or other operations at no additional expense to the Department.

C. Bottom of Deck Blow Through

Take all necessary precautions to prevent any blow through of the bottom of the bridge deck. In the event that blow through occurs, cease all removal or cleaning operations until the removal operation procedures are corrected and the area is repaired to the satisfaction of the Engineer.

Provide protective platforms over areas of vehicular traffic when under portions of bridges where hydro-demolition takes place. See the Plans and Specifications for additional requirements.

519.3.05 Construction

The minimum overlay thickness is to be 3.875 in. (95 mm) with a minimum of 2.25 in. (55 mm) of concrete cover over the top reinforcement mat or as specified in the plans.

A. Finishing

Pass the finishing machine or approved screeding device over the existing deck prior to placing the concrete overlay in order that measurements can be made to insure that proper overlay thickness and steel cover is achieved. Equip screeds with surface vibrators sufficient to thoroughly consolidate the overlay full depth, unless other methods are approved by the Engineer. Perform consolidation using hand-held vibrators when placing the mixture around steel reinforcement or structural members.

Satisfy the surface tolerances for the overlay as found in Section 500.3.06.E of the Standard Specifications except as noted on the Plans. After finishing, texture the surface in accordance with the requirements of Section 500.3.05.T.9.C or as required by the Plans and Proposal. Do not begin surface grooving until the curing period specified herein has expired.

B. Construction Joints

Minimize the number of longitudinal and transverse construction joints. Thoroughly clean both types of joints by blast cleaning. Coat the hardened sides of the joints with an approved bonding agent before fresh concrete is placed. When necessary, form longitudinal construction joints vertical by use of a header secured to the deck. After removal of the longitudinal header and transition, saw the overlay 3 in. (75 mm) or more inside the construction joints and the overlay outside the saw cut removed before the adjacent overlay is placed. The volume of the overlay removed is not included in the volume measured for payment**.**

C. Curing

Cure the concrete overlay for a minimum of 24 hours.

Begin curing of the overlay immediately after the water sheen disappears and the surface finish is applied. Maintain a film of water on the surface by fogging until covering materials are in place.

Apply curing covers as soon as the concrete has set sufficiently to prevent marring of the surface. Provide curing material consisting of two layers of wet burlap and at least one layer of plastic sheeting conforming to the requirements of AASHTO M-171. Lap adjacent sheets of curing covers a minimum of 6 in. (150 mm). Immediately replace sheeting materials that become torn, broken or damaged. Make provisions for additional applications of water under the plastic sheeting. This may be accomplished with soaker hoses or other methods approved by the Engineer. In any event, the overlay surface and burlap material are to remain wet throughout the curing period.

D. Weather Limitations

Place the overlay during favorable weather conditions. When the atmospheric temperature is expected to exceed 90 °F (32 °C). during daylight hours, schedule work hours that insure complete placement by 10:30 a.m. Do not schedule placement when wind velocity is expected to exceed 20 mph (32 km/hr) or when rain is expected. The minimum acceptable

temperature of concrete at the point of delivery is 70 °F (20 °C). Keep overlay concrete at a temperature above 70 °F (20°C) for at least 24 hours after placement.

E. Repair of Cracks

Repair cracks, as directed by the Engineer, occurring in the concrete deck overlay surface in accordance with Section 528 of the Special Provisions prior to grooving of the deck surface.

F. Expansion Joints

After the curing process for the overlay is completed, install new expansion joint sealing systems according to Section 449 of the Standard Specifications.

519.4 Measurement

Measurement for the concrete overlay is by the square yard of existing deck surface to be overlaid, complete in place and accepted, and includes all materials and labor to remove the existing concrete, clean and prepare the deck surface, place and finish the overlay.

Make a separate measurement for payment purposes for removing unsound concrete and the reconstruction of the existing deck for the depth directed by the Engineer. Measure the unsound concrete removal for payment by the square foot for each depth of removal category completed and accepted, including all materials and labor to remove the unsound concrete and to reconstruct the existing deck. Include all form work necessary to replace the existing deck.

519.5 Payment

Payment for the concrete overlay as specified above is paid for at the Contract Unit price bid per square yard. Such payment is full compensation for furnishing all equipment and materials and performing the work in accordance with the Plans and Specifications.

Removal of unsound concrete measured as specified above is paid for at the specified rate of payment per square foot for each depth of slab removal category. Such payment is full compensation for furnishing all equipment and materials and performing the work as directed by the Engineer, including the cost for the quantity of concrete required to replace removed unsound concrete and formwork necessary to replace the existing deck.

Payment will be made under:

Item No. 519	Portland Cement Concrete Overlay, Variable Thickness	Per square yard (meter)

Payment rate for unsound concrete removal and replacement:

Item No. 519 category (1) Unsound concrete removal to full depth of deck for slabs over metal deck forms.
Removal and Replacement …… $5.00 per square foot ($54.00 per square meter)

Item No. 519 category (2) Unsound concrete removal to full depth of deck for slabs without metal deck forms.
Removal and Replacement ……. $20.00 per square foot ($215.00 per square meter)

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA
SPECIAL PROVISION

Section 519 – Concrete Bridge Deck Overlay

Add the following:

Section 519—TWO-PART POLYMER BRIDGE DECK OVERLAY

519.1 General Description

This work includes preparation of the bridge deck and furnishing and placing of a two-part polymer bridge deck overlay at the location and thickness as indicated on the plans. This bridge deck overlay system consists of a minimum 3/8 inch (9.5mm) thick application to provide complete waterproofing as well as providing a non-skid surface that withstands continuous heavy traffic and extreme changes in weather conditions.

519.1.01 Definitions

A. Standard Specifications

General Provision 101 through 150.

Section 107 – Legal Regulations and Responsibility to the Public

Section 504—Twenty-Four Hour Accelerated Strength Concrete

Section 886—Epoxy Resin Adhesives

Section 934—Rapid Setting Patching Materials for Portland Cement Concrete

519.2 Materials

A. Submittals: Submit the bridge deck overlay materials to the Office of Materials and Research for approval. The Office of Materials and Research will grant approval based on laboratory test results and on the system's performance during a 2 year field evaluation.

B. Pre-treatment: Use pre-treatment only when recommended by the overlay manufacturer. Use pre-treatment consisting of a two-part hybrid polymer that is free of any fillers or volatile solvents and formulated to provide simple volumetric ratio of two components such as one to one or two to one by volume. Formulate the two-part hybrid polymer to provide a unique combination of extremely low viscosity and low surface tension coupled with an affinity for concrete and steel. Use two-part hybrid polymer pre-treatment having the following physical requirements when cured:

PHYSICAL PROPERTIES FOR CURED PRE-TREATMENT SYSTEM		
TEST	**REQUIREMENTS**	**TEST METHOD**
Compressive Strength	5,500 PSI (38MPa) min.	ASTM C 109
Tensile Strength	3,100 PSI (21MPa) min.	ASTM D 638
Tensile Elongation	30% min.	ASTM D 638

Water Adsorption	0.10% max.	ASTM D 570
Shore “D” Hardness	65 min.	ASTM D 2240
Pot Life	40-70 minutes	GDT-58
Adhesion to Concrete	100% failure in concrete	ACI-503-R (Pull Out Test)

C. Bridge Deck Overlay: Use a bridge deck overlay consisting of a two-part polymer that is free of any fillers or volatile solvents and formulated to provide simple volumetric mixing ratio of two components such as one to one or two to one by volume. Use a two-part polymer system formulated to provide flexibility in the system without any sacrifice of the hardness, chemical resistance or strength of the system. Do not use external or conventional plasticizers. Introduce flexibility by interaction of elastomers to chemically link in the process of curing so that the flexibility of the molecule is minimally affected during the low temperature conditions that are confronted in actual use. Use a two-part polymer overlay system having the following physical properties when cured:

PHYSICAL PROPERTIES FOR CURED TWO PART POLYMER OVERLAY SYSTEM		
TEST	**REQUIREMENTS**	**TEST METHOD**
Compressive Strength	7,000 PSI (48MPa) min.	ASTM C 109
Tensile Strength	2,500 PSI (17MPa) min.	ASTM D 638
Tensile Elongation	30% min.	ASTM D 638
Water Adsorption	0.20% max.	ASTM D 570
Shore “D” Hardness	60 min.	ASTM D 2240
Pot Life	15-40 minutes	GDT-58
Flexural Creep	0.0065” (0.17mm) in 7 days	California Method 419
Adhesion to Concrete	100% failure in concrete	ACI-503-R (Pull Out Test)

D. Aggregate: Use bauxite, crushed porphyry, aluminum oxide or other similarly hard durable aggregates as recommended by the manufacturer and approved by the Engineer. Use embedded exposed aggregate conforming to the following gradation.

FINE AGGREGATE GRADATION	
SIEVE SIZE	**% PASSING BY WEIGHT**
No. 4	100
No. 20	0 – 5
No. 200	0 –1.0

Broadcast coarse aggregate conforming to the following gradation over the first layer of polymer, immediately prior to broadcasting fine aggregate.

COARSE AGGREGATE GRADATION	
SIZE	**% PASSING BY WEIGHT**
5/8”	98 - 100
½”	55 – 60
3/8”	12 – 14
¼”	0 - 1

519.2.01 Delivery, Storage and Handling

Deliver all materials in their original containers, bearing the manufacturer’s label, specifying date of manufacture, batch number, trade name brand, quantity and mixing ratio.

Store all materials to prevent damage from the elements and to insure the preservation of its quality and fitness for the work. Avoid contact with flame.

Inspect all stored materials, although accepted before storage, prior to their use in the work. Ensure that all stored materials meet the requirements of the Contract at the time of use.

Remove from the site of the work immediately, any material rejected because of failure to meet the required tests or rejected because of damage. Replace all removed material at no additional cost to the Department.

519.3 Construction Requirements

519.3.01 Preparation

A. Removal and Preparation of Repair Area

Sound all visual bridge deck defects of greater than 1" X 6" (25mm X 150mm) to determine the limits of the damaged areas. Strike the deck surface around the defect with a hammer, chain drag, or other similar tool to detect unsound concrete having a "flat" or "hollow" sound. Mark the limits of the defective areas on the deck by making a rectangular area 2 inches (50mm) beyond the outer limits of the unsound concrete area to serve as a guide for sawing. Mark spalled areas within less than 6 inches (150mm) of each other as one spall area.

Saw the rectangular marked areas with near vertical faces not less than one inch (25mm) in depth. Exercise extreme care not to saw or damage the reinforcing steel. Remove all unsound material within the sawed areas. Remove concrete to a minimum depth of $^{1}/_{2}$ inch (13mm) below the top mat of reinforcing steel by power chipping or hand tools. Do not use pneumatic hammers heavier than a 15 lb. class (nominal). Do not operate pneumatic hammers and chipping tools at an angle exceeding 60 degrees relative to the surface of the deck slab. Such tools may be started in the vertical position but must be immediately tilted to a 60 degree operation angle. Clean all exposed reinforcing steel of all rust, corrosion products, oil, dirt, concrete fragments, loose scale and any other coating of any character that would destroy or inhibit the bond with the patching material. Exercise utmost care not to damage or fracture the sound concrete substrate left on the bottom of the spall repair area. Do not use sharp pointed bits.

Hold "over-cutting" of the bridge deck beyond marked areas to the minimum amount possible. Thoroughly clean all "over-cutting" of "saw slurry" and other contaminants. Then repair by filling full-depth with an approved Type II epoxy adhesive as specified in Section 886. Make such repairs as soon as possible.

Just prior to placing the patching material, thoroughly clean the surfaces within the repair areas by abrasive blasting and air blasting to remove any oil, dust, dirt, slurry from saw operation, and other contaminants. Remove abrasives from the blasting operation from the bridge deck. During blasting, protect traffic in adjacent lanes.

B. Placement of Patching Material

The Contractor shall use Repair Method No. 1 or Method No. 2 as described below. For both repair methods, ensure the surface within the repair areas is dry and thoroughly cleaned of all contaminants immediately before placement. Use air compressors equipped with suitable traps capable of removing all surplus water and oil in the compressed air for cleaning repair areas. Do not use contaminated air. Use air compressors capable of delivering compressed air at a continuous pressure of 90 psi (620kPa).

Ensure the finished surface meets a surface tolerance of $^{1}/_{16}$ inch (1.6mm). Utilize such approved measures as necessary to keep the deck surface adjacent to the patching operation reasonably clean of excess grout and other materials at all times. Unless otherwise specified, complete all patching operations and open all lanes to traffic before sunset each day.

1. **Repair Method No. 1 (24 Hour Accelerated Strength Concrete)**

   After the repair area preparation is complete, completely coat all concrete surfaces within the repair area with a film of Type II epoxy at a thickness of 10 to 20 mils (0.25 to 0.50mm).

   Use concrete meeting the requirements of Section 504. Mix the concrete on site. Use a mix design and mixing method approved by the Laboratory. Deposit concrete in the repair area while the epoxy is still tacky and vibrate sufficiently to form a dense, homogeneous mass of concrete, completely filling the area of the patch. Screed the concrete to the proper grade and allow to remain undisturbed until the water sheen disappears from the surface. Then cover the concrete with wet burlap or membrane curing compound. Continue curing for a minimum of 3 hours. The Engineer may require a longer curing time to ensure sufficient strength development of the concrete prior to opening to traffic.

2. **Repair Method No. 2 (Rapid Setting Patching Material)**

   Follow the above requirements for Repair Method No. 1. Additionally, prepare the surfaces in the repair areas in accordance with the manufacturer's written recommendations. Handle, mix, place, consolidate, screed, and cure the patching material in accordance with the manufacturer's written instructions as approved by the Laboratory. Continue curing for at least one hour and until the section is opened to traffic.

519.3.02 Construction

A. Surface Preparation: Clean the bridge deck by shotblasting to remove any oil, dirt, rubber or any other potentially detrimental material such as curing compound and laitance which may prevent proper bonding and curing of the material.

The Contractor is directed to Section 107 of the Standard Specifications giving the Contractor responsibility for the work site, and requiring conformance to all federal, state, and local laws relating to pollution control and worker protection. In particular, ensure that the Contractor is familiar with and in full compliance with the provisions of the laws concerning the management of waste and worker protection.

Do not allow construction traffic on any portion of the deck that has been shotblasted or on the overlay without specific approval of the Engineer. Overlay the deck surface within 24 hours of the surface preparation operation.

Ensure all surfaces to be overlaid are dry at the time of application. Immediately before applying the overlay system, clean all prepared surfaces with compressed air (or vacuum) to remove dust and debris. Use air compressors equipped with a filter to prevent oil in the air supply. Do not apply the overlay system when rain is forecast to occur within 24 hours of application. Do not apply the overlay system unless the minimum ambient temperature is 50^{o} and rising.

If, in the opinion of the Engineer, the surface has become soiled or contaminated prior to the application of the overlay, re-clean the surface to the satisfaction of the Engineer at no additional cost to the Department.

B. Field Test: Prior to commencing the overlay operation, place a test area of overlay on the bridge deck. Prepare the area for the test overlay as described above. Ensure the test is large enough so the cleaning equipment and methods to be employed in the full-scale operation can be used for the field test. Ensure the degree of cleaning used on the test area is the minimum used on the remainder of the structure. Use the application of the overlay system to the test area to establish proper procedures and techniques for applying the overlay to the full structure.

After the test area has cured for 72 hours, check adhesion in accordance with ACI 503R-1980. Test a minimum of three sample areas. Ensure no adhesion test has an adhesive strength less than 250 psi (1725kPa) and the minimum average value for the 3 tests is greater than 300 psi (2070kPa).

If the test of a sample area fails to meet the above requirements due to a cohesive failure of the concrete substrate, the adhesive strength of the sample area will be considered acceptable. Successful completion of the adhesive strength tests will be required before the full-scale overlay operation is to begin.

C. Application: Provide suitable coverings, such as heavy duty drop cloths, to protect all exposed areas not to be overlaid, such as curbs, railings, parapets, deck drains, locations of expansion joints that are to receive expansion joint membranes, etc. Clean or repair any damage or defacement resulting from the application, at the Contractor's expense, to the satisfaction of the Engineer.

Ensure the application of the overlay system is done by the supplier, or by a factory trained or licensed applicator, with written approval from the manufacturer of the overlay system.

Ensure each component of the two-part polymer is metered, mixed together, and distributed onto the deck by machine. Use a dispensing machine capable of ratio check verification at the pump outlets as well as cycle counting to monitor output. Ensure the in line mixing is motionless so as not to overly shear the material. Ensure the machine makes maximum use of the working time of the polymer by mixing it immediately prior to dispensing onto the deck.

Provide the number of layers and the application rates of the materials in the various layers as recommended by the manufacturer in order to achieve a minimum $^{3}/_{8}$ inch (9.5mm) and maximum ½ inch (13mm) overlay thickness when measured from the top of the concrete substrate to the top of the polymer (not the peaks of the aggregate). Ensure the application of the overlay system is as follows:

1. APPLICATION OF POLYMER: After mixing of the components, evenly distribute the polymer on the clean, dry deck surface at the rate recommended by the manufacturer.
2. APPLICATION OF AGGREGATE: After application of each layer of polymer, allow a minimum lapse period as required by the manufacturer's instructions before broadcasting the aggregate. Ensure the method and rate of aggregate application is in accordance with the manufacturer's recommendations.

3. CONSOLIDATION: If required by the manufacturer, use a hand operated roller as approved by the Engineer and the manufacturer within 10 minutes of the aggregate application to evenly consolidate the aggregate into the polymer.

4. REMOVAL OF EXCESS AGGREGATE: After initial cure, remove excess aggregate by a power vacuum or other Engineer approved method prior to the application of subsequent layers of polymer.

5. APPLICATION OF ADDITIONAL LAYERS: Additional layers may be applied immediately after the initial set of the preceding layer (as determined by the Manufacturer and Engineer) and removal of all excess aggregate. The maximum time allowed between each layer shall be at the discretion of the Engineer and the Manufacturer and may vary depending on the temperature and circumstances of the project. Ensure joints are staggered and overlapped between successive layers so that no ridges will appear.

6. TRAFFIC CONSIDERATIONS: Traffic may be allowed on the final layer after the polymer has reached its final cure (as determined by the Manufacturer) and after removal of all excess, loose aggregate.

7. OVERLAY SURFACE: Ensure the finished surface consists of a uniform coat of imbedded exposed aggregate.

519.3.03 Quality Acceptance

A. Thickness Verification

Ensure the overlay is at least $^{3}/_{8}$" (9.5mm) thick as measured from the concrete substrate to the top of the polymer at three random locations for every 1000 yd^2 (830 m^2) of surface area. Recoat thin areas as described above and re-verify thickness at no additional cost to the Department. This verification may consist of cores, holes, etc., but in all cases repair any areas tested to destruction before final acceptance.

In thin areas that have been recoated to obtain the required minimum thickness, the Engineer may require additional adhesion strength tests in accordance with ACI 503R-29 to verify the Contractor's procedure for recoating existing overlay.

519.3.04 Contractor Warranty and Maintenance

The polymer manufacturer and the Contractor, by acceptance of the work described in this Specification, shall jointly agree to guarantee the wearing surface against all defects incurred during normal traffic use for a period of ten years. Submit this agreement in writing to the Engineer signed by both the polymer manufacturer and the Contractor. Commence the ten year period on the date of acceptance of the work. The guarantee shall cover all labor and materials required by the Department to satisfactorily repair and replace the wearing surface.

519.4 Measurement

519.4.01 Surface Preparation:

Measure the area of the deck acceptably repaired and blast cleaned prior to installation of the overlay in square yards (meters) computed from surface measurements taken to the nearest 0.1 foot (30mm). Do not measure the blast cleaning of any longitudinal or transverse construction joints or vertical surfaces for payment.

519.4.02 Polymer Overlay:

Measure the area of the deck acceptably overlaid with polymer and broadcast spread crushed aggregate in square yards (meters) computed from surface measurements taken to the nearest 0.1 foot (30mm).

519.5 Payment

519.5.01 Surface Preparation:

Surface preparation is paid for by the square yard (meter) of the deck acceptably repaired and blast cleaned prior to installation of the overlay. Payment includes all expenses associated with removal of existing concrete, repair and blast cleaning operations.

519.5.02 Polymer Overlay:

Polymer overlay is paid for by the square yard (meter) of the deck overlaid, complete in place and accepted, provided, however, that the specified minimum overlay thickness requirement is met. The individual layers necessary to attain the specified thickness will not be paid for individually. Payment includes all labor and material cost, procurement, handling, hauling and processing, coring for thickness verification, guarantee, and includes all equipment, tools, labor, and incidentals necessary to complete the work.

Payment will be made under:

Item No. 519	Surface Preparation	Per square yard (meter)
Item No. 519	Polymer Overlay	Per square yard (meter)

Item No. 519-0515 Surface Preparation per Square Yard (Meter)

Item No. 519-0530 Polymer Overlay per Square Yard (Meter)

Revised: March 27, 2013

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

PROJECT NO.

SECTION 520—PILING

Delete Sub-Section 520.3.05.D.1 and substitute the following:

520.3.05.D.1. Determine Driving Resistance
Drive piles in one continuous operation. Determine the driving resistance of the piling based on the method specified in the plans, which will be one of the following methods (a – c):

a. Upon completion of the dynamic pile testing in accordance with Special Provision Section 523. The pile bearing will be determined by computing the penetration per blow with less than ¼-inch (6-mm) rebound averaged through 12 inches (305 mm) each of penetration. When it is considered necessary by the Engineer, the average penetration per blow may be determined by averaging the penetration per blow through the last 10 to 20 blows of the hammer. In soft material the driving resistance may be determined, at the Engineer's discretion, after delaying driving operations and performing pile re-strikes.

b. Upon completion of the loading test in accordance with Sub-Section 520.3.05.D.2.

c. Using FHWA-modified Gates Formula as provided below:

$R_{ndr} = 1.75\ (E_d)^{0.5} \log_{10}(10N_b) - 100$ (kips) U.S units

$R_{ndr} = 7\ (E_d)^{0.5} \log_{10}(10N_b) - 550$ (kN) S.I. units

Where:

R_{ndr} = nominal pile driving resistance measured during pile driving

E_d = developed hammer energy. This is the kinetic energy in the ram at impact for a given blow. If ram velocity is not measured, it may be assumed equal to the potential energy of the ram at the height of the stroke, taken as the ram weight times the actual stroke (ft-lb for U.S units, kN-m for S.I. units)

N_b = Number of hammer blows for 1.0 inch of pile permanent set (blows/in)

These resistance formulas apply only when:

- The hammer has a free fall.
- The head of the pile is not broomed, crushed, spalled, or excessively crimped.
- The penetration rate is reasonably uniform.

Determining driving resistance by formula is not a Pay Item. Provide the facilities for determining driving resistance by formula as an incidental part of the work.

Once the driving resistance has been determined by one of the methods noted above, do not continue to drive piles if the Engineer determines that the piles have reached practical refusal. Practical refusal is defined as 20 blows per inch with the hammer operating at the highest setting or setting determined by the Engineer and less than ¼-inch (6-mm) rebound per blow. The Engineer will generally make this determination within 2 inches (51 mm) of driving. However, the Engineer will not approve the continuation of driving at practical refusal for more than 12 inches (305 mm). When the required pile penetration cannot be achieved by driving without exceeding practical refusal, use other penetration aids such as jetting, spudding, predrilling or other methods approved by the Engineer.

d. Wave Equation: Use the Wave Equation Analysis for Piles (WEAP) program to evaluate the suitability of the proposed driving system chosen from the methods noted above (including the hammer, follower, capblock and pile cushions) as well as to estimate the driving resistance to achieve the pile bearing requirements and to evaluate pile driving stresses. Use the WEAP program to show that the hammer is capable of driving to a resistance equal to at least twice the factored design load plus the scour and down drag resistance (if applicable) shown in the Plans without overstressing the piling in compression or tension.

Perform the WEAP analysis with personnel who are experienced in this type work, and have performed this analysis on a minimum of 15 projects. Provide a list of the qualifications and experience of the personnel to perform the WEAP analysis for this Project.

The Engineer may modify the scour resistance shown in the plans if the dynamic pile test is used to determine the actual soil resistance through the scour zone. Also, the Engineer may make modifications in scour resistance when the Contractor proposes drilling and/or jetting to reduce the soil resistance in the scour zone.

A minimum of two weeks prior to beginning any pile driving operations, submit to the Engineer for evaluation and approval the following information on all of the proposed pile driving system(s) to be used on the Project including but not limited to:

i. Pile driving hammer
ii. Hammer and pile cushion types, properties and thicknesses
iii. Drive head weight
iv. Pile type, properties and length
v. Other information on the driving system required by the Engineer
vi. A WEAP program output indicating the approximate depth or elevation where the pile will achieve the bearing required

If WEAP analyses show that the hammer(s) will overstress the pile, modify the driving system or method of operation as required to prevent overstressing the pile. Resubmit the modified pile driving system information and WEAP program output to the Engineer for re-evaluation. Do not begin pile driving operations until the Engineer has approved the qualifications of the personnel, the WEAP program output, and the pile driving system(s).

Approval of the pile driving system(s) is also based on satisfactory field trials with dynamic pile testing. Obtain approval from the Engineer for the pile driving system(s) based on satisfactory field performance.

If piles require different hammer sizes, the Contractor may elect to drive with more than one size hammer or with a variable energy hammer, provided that the hammer is properly sized and cushioned, will not damage the pile, and will develop the required resistance.

For penetration of weak soils by concrete piles, use thick cushions and/or reduced stroke to control tension stresses during driving.

Revised 10/07/13

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

PROJECT NO. 00000-0000-00(000), County
P.I. NO. 000000

SECTION 524 – DRILLED CAISSON FOUNDATIONS

524.1 General Description

This Work consists of furnishing all labor, materials, equipment, tools and services necessary for construction of drilled caisson foundations and includes all incidentals and additional work in conjunction therewith. Adhere to the Department's Plans, Special Provisions and Standard and Supplemental Specifications for all Work.

524.2 Materials

Use materials that meet the requirements of the Standard Specifications with the following exceptions:

- Follow Special Provision 500 – Concrete Structures (Mass Concrete), for shafts with diameters greater than 6 feet (1.83 meters).
- Use non-air-entrained Class AA concrete with a coarse aggregate size of No. 67 stone and a slump at time of placement of between 7 and 9 inches (178 mm and 229 mm). Use 10 percent additional cement and a retarder or water reducing agent in all concrete.
- Use Grade 60 (Grade 420) reinforcing bars that conform to ASTM 615 (ASTM A 615M). If wire spirals are used, use spirals that conform to ASTM A 82.
- Use Grade 2 steel casing that conforms to ASTM A 252.

524.3 Construction Requirements

524.3.01 Personnel

Construct drilled caissons and supervise the work with personnel who are experienced in this type work. Visit and examine the work site and all conditions, and take into consideration all such conditions that may affect the work. At least 30 days prior to beginning drilled caisson work, submit to the Engineer for review and approval the following proof of the ability of the personnel to construct drilled caisson foundations:

1. Evidence of the successful completion of at least five projects similar in concept and scope to the proposed foundation. Include names, addresses and telephone numbers of the owners' representatives for verification.

2. Résumés of foreman and drilling operators to be employed on this project. Provide evidence showing that the drill operator has experience and knowledge of the drill rig to be used on the project. The Department will be sole judge of the qualifications of the foreman and drill rig operator.

3. A detailed sequence of construction for drilled caisson work that describes all materials, methods and equipment to be used, including, but not limited to the following:

    - casing sizes with proposed top and tip elevations
    - drilling equipment including the manufacturer's specifications on the drill rig
    - methods and equipment for stabilizing and cleaning shaft excavations
    - methods of materials handling and disposal
    - methods and equipment for placing concrete
    - details of tremie and sealing methods, if required
    - details of reinforcement placement, including support and centralization methods

Do not begin drilled caisson construction until the qualifications, construction plan and methods have been approved in writing by the Engineer.

524.3.02 Equipment

Use excavation and drilling equipment with a rated capacity (including power, torque and downward thrust) to excavate a caisson of the maximum specified diameter to a depth of 40 feet (12.2 meters) or 25 percent deeper than the deepest caisson indicated on the Plans, as measured from the ground or water surface elevation, whichever is higher.

524.3.03 Casing

Use casing that is a metal shell of a thickness to withstand handling, internal and external pressures, and that is watertight, smooth and clean. If the elevation of the top of the caisson is below ground level or water level at the time of concrete placement, use an oversize casing from ground elevation to a point below the top of the caisson to prevent caving into the fresh concrete. Do not allow the top of the permanent casing, if required, to extend above the top of the drilled caisson. Use casing in all materials that do not have sufficient strength to safely remain open and stable during and after excavation.

When casing is used, do not use casing with an outside diameter less than the specified diameter of the caisson. That portion of the caisson below the casing may be slightly smaller than the normal outside diameter of the caisson. However, use drilling tools to excavate the caisson below the casing that are no smaller than the outside diameter of the casing minus 2 inches (51 mm). Do not leave casing in place unless permitted by the Engineer, and cut off any permanent casing as shown on the Plans.

Provide adequate equipment during concrete placement to prevent pulling up the reinforcing cage during casing extraction. The casing may be pulled in partial stages. Maintain a sufficient head of concrete above the bottom of the casing to overcome hydrostatic pressure. Extract the casing at a slow uniform rate with pull in line with the center of the caisson.

524.3.04 Protection of Existing Structures

Monitor structures for settlement that are within a distance of ten shaft diameters or the estimated shaft depth, whichever is greater, in a manner approved by the Engineer. Record elevations to an accuracy of 0.01 foot (3 mm). Record elevations before construction begins, during the driving of any required casings, during excavation or blasting, or as directed by the Engineer.

Document thoroughly the condition of the structures with descriptions and photographs made both before and after drilled caissons are constructed. Document all existing cracks, and provide copies of all documentation to the Engineer.

At any time settlement of 0.05 foot (15 mm) or damage to the structure is detected, immediately stop the source of vibrations, backfill any open drilled shaft excavations and contact the Engineer for instructions.

524.3.05 Excavation

Prior to excavation of each caisson, core rock at two (#) locations per shaft, within the shaft location, to be determined by the Engineer, until a sequential __ foot (__ m) core is obtained with a core recovery of rock having a minimum of __% recovery and a minimum RQD of __ is obtained. Obtain cores with a minimum diameter of 2.5 inches (63.5 mm). These cores will be inspected in order to determine the integrity of the rock at and below the planned shaft tip elevation. The Engineer will inspect the rock cores and based on the quality of the rock, additional coring may be required. At this time a determination of the soundness and quality of the rock will be made by the Engineer and the shaft tip elevation of the caissons may be adjusted by the Engineer as needed based on this information.

Test coring will be measured and paid for separately from drilled caissons.

Drill and excavate all caissons through whatever substances and to the elevations required. Excavate near the tip elevation in the presence of the Engineer. The Engineer may adjust the tip elevations depending on the quality of the bearing material found. Embed the caisson tips __ feet (__ meters) into and on top of sound rock in accordance with Plan requirements and as determined by the Engineer. Sound rock is indicated by material that cannot be drilled with a conventional earth auger, and requires the use of special rock augers, core barrels, air tools, blasting and/or other methods of hand excavation. Sound rock is defined as material on which the rock auger penetration is equal to or less than 2 inches (51 mm) per five minutes of drilling with the auger subjected to a torque of 600,000 inch-pounds (67,791 kN-m) with a down thrust of 37,000 pounds (165 kN). There will be no additional compensation for removal of rock.

Remove sediment and debris from the bottom of the caissons. Do not place the reinforcing steel or concrete until the Engineer has approved the bottom of each caisson.

Where drilled caissons are located in other than open water areas, use casings or other methods approved by the Engineer to stabilize the excavation and control the hole size. When casing is not specifically required on the plans, fill in any over-excavations with Class AA concrete at no

additional cost to the Department. Dispose of excess concrete, grout, displaced water and materials removed from the caisson excavation in areas approved by the Engineer, and in accordance with any Federal, State, or local code or ordinance. Verify the accuracy and existence of all applicable codes, ordinances or other regulations prior to disposing materials.

524.3.06 Reinforcing Steel

Assemble a cage of reinforcing steel and place it as a unit immediately prior to concrete placement. Assemble the cage so that the clearance between the cage and side of the caisson will be at least 5 inches (125 mm), and the clearance between the cage and bottom of the caisson will be 3 inches (76 mm).

If the caisson is lengthened, extend all reinforcement to within 3 inches (76 mm) of the bottom. If a splice is required, place it in the lower one-third of the caisson, or as shown on the Plans. Tie hoops or spirals to the caisson and column steel (vertical bars) at 100% of the junctions with double wire figure-eight ties. Do not weld the reinforcing steel. Support the cage from the top in a concentric manner to minimize its slumping downward during concrete placement and/or extracting the casing.

Check the elevation of the top of the steel cage before and after casing extraction. Any upward movement of the steel not exceeding 2 inches (51 mm) or any downward movement thereof not exceeding 6 inches (152 mm) will be acceptable. Any upward movement of the concrete or displacement of the steel beyond the above limits will be cause for rejection. Tie and support the reinforcing steel in the caisson so that the reinforcing steel will remain within allowable tolerances. In uncased caissons, use only heavy-duty plastic rollers (wheels). In cased caissons, use heavy-duty non-corrosive plastic rollers (wheels) or steel chairs. Place rollers at maximum intervals of 8 feet (2.4 meters) along the cage to ensure concentric spacing for the entire cage length. Use one roller for each one foot (305 mm) of diameter of the cage, with a minimum of four rollers at each interval. Do not use concrete spacer blocks. Use rollers that are constructed of a material approved by the Engineer and that have sufficient bearing surface to provide lateral support to the reinforcing cage.

Use rollers of adequate dimension to provide the annular spacing between the outside of the reinforcing cage and the side of the excavated hole or casing as shown on the Plans. If an oversize casing is used, use rollers that will provide concentric spacing. Use pre-cast concrete or heavy-duty plastic bottom supports (feet/boots) to provide a spacing of 3 inches (76 mm) between the cage and caisson bottom.

524.3.07 Concrete

Mix and place all concrete in accordance with Section 500 of the Specifications where applicable or in accordance with Special Provision 500 – Concrete Structures (Mass Concrete) if shaft diameters are greater than 6 feet (1.83 meters), and the requirements herein stated.

Place concrete as soon as possible after all excavation is completed and reinforcing placed and supported. Place concrete continuously in the caisson to the top elevation of the caisson. The Engineer may allow free falling of concrete to a maximum of 60 feet (18.3 meters), if satisfactory methods are demonstrated.

If ground water is encountered and the hole can not be pumped dry, or if the Engineer does not approve free fall of concrete, place concrete using a gravity feed watertight tremie. Use a tremie pipe of at least 8 inches (203 mm) in diameter with a concrete hopper at the top. The Engineer may allow concrete to be placed by pumping through a supply line if satisfactory methods are demonstrated. If this method is allowed, use pump supply lines with watertight couplings. Seal the end of the pump

line with a foam plug or other device approved by the Engineer to prevent concrete within the tremie or pump supply line from mixing with fluid in the excavation.

If a tremie is used, place it on the bottom of the excavation at the beginning of concrete placement, and keep it there until the tremie pipe and hopper are filled with concrete. Then raise the tremie only enough to induce concrete flow and do not lift the tremie further until the discharge end is immersed at least 10 feet (3.1 meters) into the deposited concrete. If concrete placement by pumping is used, secure the supply line in place so that the discharge end will not lift off the bottom of the excavation more than 6 inches (152 mm) until at least 10 feet (3.1 meters) of concrete has been placed. Embed the discharge end of the tremie or pump supply line a minimum of 10 feet (3.1 meters) in the concrete throughout the remainder of the concrete pour.

Complete the placement of all concrete in the caisson in twelve hours. Adjusted the retarder or water reducing agent as approved by the Engineer for the conditions encountered on the job so the concrete remains in a workable plastic state throughout the pour.

Prepare and cure the top surface of the construction joint in accordance with the requirements of Section 500. Locate construction joints as indicated on the Plans.

Do not place concrete under water in the caisson excavation without the permission of the Engineer. When permission is granted, place the concrete in accordance with the requirements of Section 500. Provide a sump to channel displaced water away from the caisson. Contain all displaced water to prevent water from entering into any body of water.

During the twenty-four hour period immediately following the completion of the placement of concrete in the caisson, do not install or extract casing within 50 feet (15.2 meters) of the completed caisson, and do not excavate any caissons within 15 feet (4.6 meters) of the completed caisson. If the Engineer determines that any construction adversely affects the recently constructed caisson, cease such activities immediately.

Protect any portion of drilled caissons exposed to a body of water from the action of water by leaving the forms in place for a minimum of seven days after pouring the concrete. Remove the forms prior to 7 days only if the concrete strength has reached 3000 psi (20.7 Mpa) or greater as tested by cylinder breaks.

524.3.08 Inspection and Safety

1. Check the dimensions and alignment of the caisson excavation under the observation of the Engineer.

524.3.08 Tolerances

Adhere to the following construction tolerances for drilled caissons:

1. Construct the drilled caisson to within 3 inches (76 mm) of the plan position plane, at the top-of-caisson elevation. Adhere to a vertical alignment tolerance of ¼-inch per 12 inches (6 mm per 305 mm) of depth.

2. Place reinforcement in accordance with the requirements of Section 511 of the Standard Specifications and Sub-section 524.3.06. Tie column steel (vertical bars) to hoops and spirals at 100% of the junctions with double wire figure-eight ties.

3. Placed vertical caisson reinforcing bars, including bars extending into columns or footings to within ½-inch (13 mm) of plan location. Place hoops or spirals to within 1 inch (25 mm) of their specified location. Adhere to a side form clearance of within ¼-inch (6 mm) of plan requirements.

4. Place the construction joint of the top of caissons used as caisson/column intermediate bents to within a tolerance of plus or minus 3 inches (76 mm) of the plan elevation.

524.4 Acceptability

In the event that significant voids are suspected in the concrete that were created during placement, verify the integrity of the caisson using a method that has been approved by the Engineer. If the caisson in question is found to be structurally deficient or out of tolerance in any way, the caisson will not be accepted unless corrective measures as approved by the Engineer are accomplished. Furnish additional materials and work necessary to effect corrections at no cost to the Department and with no increase in contract time.

524.5 Measurement

The length of accepted caisson foundation is measured in linear feet (meters) of caisson in place in the completed work. The length is measured from the final approved bottom elevation to 1 foot (305 mm) above the bottom of the footing cap where caissons are used in a footing or to the top of the caisson elevation detailed in the plans.

Test coring, where required, is measured in linear foot (meters) of rock coring from the top of the hard rock to the required depth below the drilled caisson tip elevation. No separate measurement is made for test coring through soil, concrete, water, or void spaces.

524.6 Payment

Drilled in place caisson foundations is paid for at the unit price bid per linear feet (meters) complete and in place as specified. The payment is full compensation for all excavation, furnishing and placement of reinforcing steel and concrete in the caisson, all temporary and permanent casing, disposal of excavated materials, and the cost of furnishing all tools, safety devices, labor, equipment and all other necessary items to complete the work.

Test coring is paid for at the unit price for test coring as specified. No separate payment is made for test coring through soil, water, concrete, or void spaces. The payment is full compensation for coring through all materials, setting casing, disposal of excavated materials, providing rock core boxes, boring logs, and the cost of furnishing all tools, labor, equipment, supplies, and all other items necessary to complete the work.

Payment will be made under:

Item No. 524-0010 DRILLED CAISSON_____INCHES (mm) DIA.….PER LINEAR FOOT (METER)

Item No. 524-0350 TEST CORING……..PER LINEAR FOOT (METER)

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

Section 581—Pot Bearings

Retain Section 581 as written and add the following:

Disc Bearings

581.6 General Description

This work includes furnishing and installing disc bearings (fixed and expansion types). Use the quality, type, and size designated in this Specification, on the Plans, or ordered by the Engineer.

581.6.01 Definitions

General Provisions 101 through 150.

581.6.02 Related References

A. Standard Specifications

Section 501—Steel Structures

Section 506—Expanded Mortar

Section 535—Painting Structures

Section 851—Structural Steel

Section 852—Miscellaneous Steel Materials

Section 885—Elastomeric Bearing Pads

Section 886—Epoxy Resin Adhesives

Section 887—Bearing Plates with Polytetrafluroethylene Surfaces

B. Referenced Documents

ASTM A 709 Grade 36 (ASTM A 709M Grade 250)

A 709 Grade 50 (A 709M Grade 345)

581.6.03 Submittals

Provide the following reports to the Project Engineer and the Office of Materials and Research:

- Certified test reports
- Materials certificates
- Certificate of Compliance to conform with the requirements in this Specification
- Shop drawings
- Certification

A. Shop Drawings

Before fabricating the bearings, submit to the Engineer Shop Drawings according to Subsection 501.1.03.B, "Shop Drawings." Include the following on the drawings:

- Bearing plan and elevation
- Complete details and sections that show the materials incorporated into the bearing
- ASTM or other material designations
- Vertical and horizontal load capacity
- Rotation and translation capacity
- Compression stress on sliding surfaces and elastomeric surfaces at maximum and minimum design loads
- Complete design calculations
- Complete erection and installation procedure

B. Certification

Have the disc bearing manufacturer furnish the following to the Project Engineer and the Office of Materials and Research:

- Certified test reports
- Material certificates
- Certificate of compliance to conform with these Specifications for each bearing furnished

581.7 Materials

Ensure that materials meet the requirements of the following Specifications:

Material	Section
Painting	535
Structural Steel	851
Anchor Bolts, Nuts, and Washers	852.2.02
Elastomeric Bearing Pads	885
Epoxy Resin Adhesives	886
Bearing Plates with PTFE Surfaces	887

A. Metals

Use the stainless steel sliding surfaces indicated below:

- Stainless Clad Steel Plate: Minimum eight percent stainless steel conforming to the requirements of ASTM A 264 (both Shear Strength and Bond Strength tests in 8.13 and 8.14 of ASTM A 264 are required). Use stainless steel cladding that meets Type 304. Use backing steel (base metal) that meets ASTM Designation A 709 Grade 50W(A 709M, Grade 345 W).
- Stainless Steel Plate Welded To A Steel Backup Plate: Use at least 16 gage (1.6 mm) thickness of the stainless steel plate that meets ASTM 240 Type 304. Use steel backing plate that meets ASTM Designation A 709 Grade 50W (A 709M Grade 345W) unless otherwise indicated on the Plans. Use qualified welders to weld the stainless steel plate to the steel backing. Furnish welding procedures and welder qualification documents to the Department for review and approval prior to fabrication. Weld entirely around the perimeter of the stainless steel plate.
- Solid Stainless Steel Plate: Mill-finish the stainless steel sliding surfaces to a maximum surface roughness of 20 micro-inches (0.50µm), RMS, according to the requirements of ANSI Standard B 46.1. Remove and replace, at no additional cost to the Department, bearing plates whose stainless steel sliding surfaces have been scratched or damaged.

B. Structural Steel

Use structural steel for the masonry plates and the components of the bearings that meet the requirements of these ASTM Specifications:

- ASTM A 709, Grade 36 (ASTM A 709M, Grade 250)
- A 709, Grade 50 (A 709M, Grade 345)

Machine the steel plates confining the disc from solid steel plates.

C. Anchor Bolts

Use anchor bolts, including nuts and washers, that meet the requirements of Subsection 852.2.02.

D. Polyether Urethane Elastomeric Disc

Ensure that the disc material is 100 percent polyether urethane meeting the following Specifications:

Property	Test Method	Range of Values
Hardness, Durometer D	ASTM D 2240	62 + or -2
Tensile Stress psi at 100% elongation at 200% elongation	ASTM D 412 Pulled at 20 in/min. (pulled at 8.5 mm/s)	2,030 minimum 3,771 minimum (14 minimum) (26 minimum)
Tensile Strength	ASTM D 412	5,000 minimum (34.5 minimum)
Ultimate Elongation, %	ASTM D 412	220 minimum
Compression Set, 22 hours at 159 degrees F., % (71° C, %)	ASTM D 395	40% maximum
Compression Strain, % at 5,000 psi stress* (35 MPa)		Strain % 8.0 min 15.0 max

* Compression stress is based on the net plan area of the rotational element and the compressive strain is the percentage of the original thickness. Gross bearing dimensions shall have a tolerance of -0 inch to + 1/8 inch (-0 mm to +3 mm).

E. Shear Restriction Mechanism

Design a shear restriction mechanism to take horizontal forces at all possible vertical loads that consists of a pin connected to the bottom plate and a ring connected to the upper bearing plate.

F. Expanded Mortar

Set anchor bolts in preformed or drilled holes using expanding mortar that meets the requirements of Section 506.

G. Paint

Paint exposed steel of each bearing assembly other than stainless steel according to System VI of Section 535. Take care to keep Polytetrafluroethylene (PTFE) or sliding surfaces free of paint.

H. Design and Applicable Codes

Design, fabricate, and erect disc bearings according to these Specifications and the applicable requirements of the following Standard Codes and Specifications.

- Section 501, including supplements

- Current AASHTO Standard Specifications for Highway Bridges

Additional design parameters with which the disc bearing manufacturer must comply:

1. Bearing on Concrete: Maximum bearing pressure is as indicated in AASHTO.
2. Polyether Urethane Disc: Design compressive strength is 5000 psi (35 MPa).
3. Virgin PTFE: Design compressive strength is 3,500 psi (25 MPa).
4. Sliding Surfaces: Accommodate translation by sliding of a hard mating surface of stainless steel across a PTFE surface.
    a. Stainless Steel Sliding Surface: Accurate, flat surface with Brinnell hardness of 125 minimum.
        1) Stainless steel sliding surface to completely cover PTFE surface in all operating positions of the bearing.
        2) Position the stainless steel sliding surface so that the sliding movement causes the dirt and dust accumulation to fall from the surface of the stainless steel.
    b. PTFE Sliding Surface: Do not use holes or slots in the PTFE sliding surface.
    c. Static Coefficient of Friction: Under a load of 3,500 psi (25 MPa), do not exceed 4 percent for unfilled PTFE nor 8 percent of filled PTFE surfaces.
    d. Rotation: 0.03 radians maximum.

I. Substituted Bearings

Disc bearings may be substituted for the bearings shown on the Plans provided the bearings to be substituted are approved by the State Bridge Engineer and comply with the following:.

1. Equal or better load carrying and moment capacity.
2. All control dimensions are maintained and bearings fit within the limits of detailed masonry plate.
3. Use filled or unfilled (recessed) PTFE.
4. Use Polyether Urethane disc material as a medium within the shear restricted disc bearing.
5. The Polyether Urethane disc shall be lined with PTFE on the bottom side of expansion guided bearings.
6. Do not use aluminum or aluminum alloy.
7. Equal or better than the pot bearings shown on the Plans in all structural respects and meets all design requirements.

581.7.01 Delivery, Storage, and Handling

A. Assembling and Marking

Have each disc bearing assembled at the plant, marked for identification, and delivered to the construction site as a complete unit.

Mark each bearing with permanent match-marks to indicate the normal position of the bearing.

B. Transportation, Storage, and Handling During Construction

Follow these guidelines to transport, store, and handle disc bearings during construction:

1. Protect each disc bearing from dust and moisture.
2. Store the PTFE surface in the shade to avoid the damaging effects of ultraviolet rays.
3. Protect the disc bearings from damage during construction and prevent contamination of the various components of the disc bearings.

Ensure that the Fabricator also follows the above requirements.

During transportation and storage, cover the bearings with moisture-proof and dust-proof covers.

581.8 Construction Requirements

581.8.01 Personnel

A. Skilled Representative

Have the bearing manufacturer provide a skilled representative who is certified by the manufacturer to be experienced in similar installations.

The representative shall:

- Give aid and instruction during the disc bearing installation.
- Be present during the initial bearing installation.
- Be present during welding of the lower steel plates to the masonry plates, if not performed in the manufacturer's shop.
- Remain on the job until the bearing installation proceeds without trouble and until the workmen are experienced with the work for each installation as determined by the Engineer.

Arrange to have the manufacturer's skilled representative present whenever requested by the Engineer.

581.8.02 Equipment

General Provisions 101 through 150.

581.8.03 Preparation

General Provisions 101 through 150.

581.8.04 Fabrication

A. Polytetrafluroethylene (PTFE)

Ensure that the PTFE, including its connection to its backup material, conforms with the requirements of Section 887, except as modified in this Specification.

Have the PTFE sliding surface bonded under factory controlled conditions to a rigid backup material that can resist bending stresses of the sliding surfaces.

As an alternate, PTFE material of twice the thickness specified above may be recessed for half its thickness in the backup material. Ensure that it is at least 1/8 in (3 mm) thick and that the PTFE sliding surface is bonded under factory controlled conditions.

1. When shown on the Plans, weld the lower steel plate to the masonry plate before installing the disc.

   If welding procedures established and approved by the Engineer restrict the temperature of the bond area to no greater than 300 °F (150 °C), welding to steel plates with a bonded PTFE surface is permitted.

   Use temperature-indicating wax pencils or other suitable means to determine the temperature.
2. After fabricating the backup material, plane it before bonding the stainless steel or PTFE to a true plane surface.
3. Have the PTFE sheets bonded at the bearing manufacturer's factory under controlled conditions in accordance with the written instructions of the manufacturer of the approved adhesive system.
4. When epoxy bonding PTFE sheets, ensure that the side of the PTFE sheet to be bonded to the metal is factory treated by the sodium napthalene or sodium ammonia process.
5. After the bonding operation, ensure that the PTFE surface is smooth, flat, and bubble free. Polish the filled PTFE surfaces.
6. Positively locate the elements of the bearing in the bearing manufacturing and assembling.
7. If using bearings other than those detailed on the Plans, obtain approval before constructing the substructure upon which the bearings will be installed.
8. Have each bearing assembled at the manufacturer's plant, marked for identification, and delivered to the construction site as a complete unit.

   Ensure that the bearings have permanent match-marks to indicate the normal position of the bearing.

581.8.05 Construction

A. Erection

Place bearings at their proper locations before erecting the superstructure supported by the bearings.

1. Install Pier Tops

   Install pier tops horizontal at the correct elevation with a plus or minus tolerance of zero. Do not install the masonry plates until the Engineer accepts the pier tops.

2. Install the Anchor Bolts

   Cast anchor bolts in the concrete or set them in preformed holes, unless otherwise shown on the Plans. If setting them in preformed holes, fill the preformed holes in the concrete substructure with epoxy grout.

   a. Insert the anchor bolts to the prescribed depth.

   b. Place additional grout as required in the annular space around the anchor bolts until the grout is well packed and flush with the top surface of the concrete.

   c. Wipe clean the exposed surfaces of the anchor bolts and substructure. Do not allow a load on grout that has not been in place at least 7 days.

3. Install Masonry Plates

   Set the masonry plates to the proper elevation on the previously finished concrete pads.

4. Install the Bearings

   a. Place the bearing at the predetermined locations when erecting the superstructure.

   b. Remove the temporary restraints as directed by the bearing manufacturer.

   c. Adjust the bearings as follows:

      - Adjust the expansion bearings from the normal position at 60 °F (15 °C) to allow for the ambient temperature during erection or casting.
      - Adjust the disc bearings to allow them to move when dead loads are applied. Ensure that the bearing is properly positioned and parallel (free from rotation) after applying the dead load.
      - Adjust the bearings horizontally on the masonry plate to properly fit the superstructure members being erected.

   d. After adjustments and approval by the Engineer, weld the bearings to the masonry plate.

581.8.06 Quality Acceptance

Instruct the manufacturer to furnish facilities to test and inspect the completed bearings in the plant or at an independent test facility. An approved testing laboratory or the manufacturer supervised by an approved independent expert shall perform the testing.

Follow these testing guidelines:

- Instruct the manufacturer to allow the Engineer and Inspectors access to the plant and test facilities.
- Furnish certified test reports, materials certificates, and a certificate of compliance to conform with the requirements in the Specifications.
- Perform testing according to Section 887 and this Specification. The Department reserves the right to sample and test the material and disc bearing assemblies as shown in Section 106.
- Test complete bearing assemblies or a specially manufactured disc bearing prototype that has a capacity of 400 kips (181 000 kg).

Successfully tested full-size bearings that meet the requirements of this subsection and have no damaged components, finishes, or surfaces may be used in construction. Provide prototype disc bearings, if used, at no additional expense to the Department.

Specific Items tested are as follows:

A. Coefficient of Friction

Perform tests to determine the static coefficient of friction of the first movement under a load of 3,500 psi (25 MPa) on a disc area applied continuously for 12 hours before testing. Determine under a load of 2,000 psi (14 MPa) on a disc area the following:

1. The static coefficient of friction value shall not exceed 10 percent for filled PTFE surfaces and 6 percent for unfilled PTFE surfaces.
2. The first movement static and dynamic coefficient of friction at a sliding speed of less than 1 in per min (0.4 mm per sec). Values shall not exceed 10 percent for filled PTFE surfaces and 6 percent for unfilled PTFE surfaces.
3. The static and dynamic coefficient of friction is determined after the bearing is subjected to 100 design movements at a speed of less than 1 ft per min (5 mm per sec). Values shall not exceed those indicated in step 2 above. Signs of bond failure or other defects are cause for disc bearing rejection.

B. Proof Loading

Perform, under maximum design loads, proof loading and compression deflection tests on a full-size disc bearing.

C. Rotation

The Polyether Urethane element shall be capable of retaining initial contact with the steel bearing plates through the rotational range under a compressive load equal in magnitude to the design load.

D. Cold Flow

Subject an approved sample of filled PTFE or unfilled PTFE to a static pressure of 3,500 psi (25 MPa) for at least 24 hours. Ensure that the PTFE material is bonded or mechanically connected to its backup material in the same way as the disc bearing.

Apparent cold flow of the PTFE material is cause for disc bearing rejection.

581.8.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

581.9 Measurement

Disc bearing assemblies are measured by Lump Sum for each bridge. Determine the actual quantities required before submitting the bid.

581.9.01 Limits

General Provisions 101 through 150.

581.10 Payment

The work in this Specification will be paid for on a Lump Sum basis.

Payment is full compensation for:

- Furnishing materials and equipment including structural steel components of the bearings, masonry plates, top plates, sole plates, PTFE, Polyether Urethane Disc, anchor bolts, and welding
- Designing the disc bearing
- Performing tests
- Furnishing prototype bearings and test samples
- Performing Work as described and specified in this Specification or the Plans
- Providing incidentals to complete the work

Payment will be made under:

Item No. 581	Pot bearings, bridge No.___	Per lump sum

581.10.01 Adjustments

General Provisions 101 through 150.

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

SECTION 628—PERMANENT SOIL NAILED WALLS

628.1 General Description

This work includes furnishing materials, labor, tools, equipment, and other incidental items to design, detail, and construct a soil nailed wall. This Specification also applies to any Contractor-proposed alternate design of Department-furnished plans.

628.1.01 Definitions

Soil Nail - Synonymous with nail or soil reinforcing

The term Soil Nailed Wall includes the following items:

- Soil nails
- Nails
- Shotcrete (pneumatically applied concrete) – for temporary facing
- Cast-in-place reinforced concrete facing – for permanent facing
- Drainage

628.1.02 Related References

A. Standard Specifications

Section 500 - Concrete Structures
Section 511 - Reinforcement Steel
Section 853 - Reinforcement and Tensioning Steel

B. Referenced Documents

General Provisions 101 through 150.

628.1.03 Submittals

A. Proof of Ability

Submit the following proof of ability (or ability of the subcontractor) when requested by the Department to design or construct soil nailed walls:

- Evidence of successfully completing at least 5 projects similar in concept and scope to the proposed wall.
- Resumes of foremen, nail testing personnel, and drilling operators to be employed on this project. Show the type, length, and number of soil nails each has installed or tested within the past 5 years.
- Evidence of experience in nail testing. Persons performing nail testing shall prove experience by performing sample tests supervised by the Engineer.

The Department is the sole judge of the qualifications of the foreman, drilling operator, and testing personnel. Do not begin wall construction until the Engineer has approved proof of ability.

B. Design Criteria for Alternate Design

If the department receives more than 2 submittals of the Plans and calculations for review, the Contractor will be assessed $60 per hour of engineering time for reviews in excess of the 2 submittals.

C. Construction Drawings and Design Notes

Submit construction drawings and design notes within 28 days of the award of the Contract. The Design Engineer shall prepare and stamp the submission. Include design notes and reproducible drawings in the submission concerning the following:

- Details, dimensions, and schedules of reinforcing steel including dowels and/or studs for attaching the facing to the soil nailed wall.
- Details of the shotcrete installation and nails, including the thickness of shotcrete and spacing and angle of installation of nails.
- Detailed plans for testing of nails showing loading and measuring devices to be used and procedures to be followed.

D. Final Wall Plans and Calculations

Submit final wall plans and calculations to the Department for review and approval before beginning construction on the wall. The time required for Plan and calculation review will be charged to the allowable Contract time. The Department has 30 days for Plan and calculation review per item after receiving the structure calculations and drawings.

New submittals from the Contractor showing corrections from the Department's review or changes to ease construction or to correct field errors have a 30-day review. The Department is the sole judge of information adequacy.

The Department's review and acceptance of the final Plans and construction methods do not relieve the Contractor from successfully completing the work. Time extensions are not granted for Contractor delays from untimely submissions or insufficient information.

E. Admixture Literature

Before using an admixture, submit the manufacturer's literature to the Engineer. Indicate the admixture type and the manufacturer's recommendations for mixing the admixtures with grout.

628.2 Materials

A. Concrete

Use concrete conforming to Section 500.

B. Reinforcing Steel

Use reinforcing steel conforming to Section 511. Reinforcing steel used as soil nails shall be full length. Couplers will not be allowed.

C. Structural Steel

Use structural steel shapes or plates conforming to Section 501. Use ASTM A 709 Grade 36 (Grade 250) structural steel unless otherwise specified on the plans.

D. Cement Grout

Produce cement grout using Portland cement conforming to AASHTO M-85, Type I, II, or III, and potable water. Use cement that is fresh and free of lumps and hydration.

Follow these restrictions if using admixtures:

1. Do not use admixtures with chemicals that may harm the soil nail, reinforcing steel, or cement.
2. Do not use admixtures that cause air bubbles in the grout.
3. If approved by the Engineer, use admixtures imparting low water content, flowability, and minimum bleeding in the cement grout.

E. Plastic

Use Polyethylene conforming to AASHTO M-252 with a minimum wall thickness of 30 mils (0.76 mm) for corrosion protection.

F. Shotcrete

Use shotcrete conforming to the following:

1. Cement – Section 830.2.01 Type I, II or III.
2. Fine Aggregate – Section 801.2.02.

3. Coarse Aggregate – Section 800.2.01.
4. Fly Ash – Section 831.2.03
5. Silica Fume – AASHTO M-307.
6. Air Entraining Admixtures for wet mix – Section 831.2.01.
7. Plasticizers – AASHTO M-194, Type A, D, F, G.
8. Use accelerating admixtures that are compatible with the cement, are non-corrosive to steel and do not promote other detrimental effects such as cracking and excessive shrinkage and do not contain calcium chloride. Use admixtures in accordance with the manufacturer's recommendations. Silica fume, if used, shall not exceed 10 percent of the cement weight and shall be an admixture with a minimum of 90 percent SiO_2 with a proven record of performance in shotcrete.
9. Use water in shotcrete that is potable, clean, free from substances which may be injurious to concrete and steel, and is free of elements which would cause staining.
10. Provide premixed and prepackaged concrete products specifically manufactured as a shotcrete product for on-site mixed shotcrete, if approved by the engineer. The packages shall contain cement and aggregates conforming to Section 500.

G. Corrosion Inhibitor

Use corrosion inhibitor (grease) conforming to the following:

1. Drop point 300 degrees F (149 degrees C) minimum by ASTM D-566.
2. Flash point 300 degrees F (149 degrees C) minimum by ASTM D-92.
3. Water content 0.1% maximum by ASTM D-95.
4. Rust test – Rust Grade 7 or better after 720 hours, aggressive conditions: Rust Grade 7 or better after 1000 hours by ASTM B-117 and ASTM D-610.
5. Water soluble ions.

Chlorides	10 ppm maximum	by ASTM D-512
Nitrates	10 ppm maximum	by ASTM D-3867
Sulfates	10 ppm maximum	by APHA 427D (15^{th} ED)

6. Oil separation – 0.5% by weight maximum at 160 degrees F (71 degrees C) by FIMS 719B, Method 321.2.
7. Soak test – 5% Salt Fog at 100 degrees F (38 degrees C), 5 mils (0.13 mm) (Q Panel Type S), immerse panels in 50% salt solution and expose to 5% Salt Fog – no emulsification after 720 hours by ASTM B117 Modified.

628.2.01 Delivery, Storage, and Handling

A. Protection Systems

Protect soil nails against corrosion by properly storing, fabricating, and handling the nail components before inserting them into the borehole. Avoid prolonged exposure of the nail components to the elements, and avoid mechanical or physical damage that reduces or impairs the component's ability to resist adverse conditions during service. Nail components will be rejected for heavy corrosion or pitting, but not for a light coating of rust.

Use the protection systems as follows:

1. Soil Nail

   Protect the entire length of the soil nail from the anchor plate to the end of the nail from corrosion.
   a. Encase the nail in a corrugated plastic tube.
   b. Use cement grout to fill the voids between the tube and the nail and the tube and the soil. Place cement grout between the soil and the tube to at least ¾ in (20 mm) thick and extend the entire length of the nail. Cement grout between the tube and the nail shall be a minimum of ½ in (12 mm) thick
   c. Provide centralizers spaced at a maximum of 5 feet (1.5 m) center-to-center throughout the nail length. Do not use wood or material harmful to the soil nail or the corrugated plastic tubing as centralizers.
   d. Provide a smooth piece of plastic sheath to encapsulate the entire free length. Do not splice the sheath. Ensure that the sheath is at least 0.05 in (1.27 mm) thick. Provide a void space between the sheath and the steel as shown on the plans and maintain that space with centralizers. Fill visible void space with grease and seal the bottom to prevent grout intrusion.

2. Area Underneath Anchorage

   Protect the area immediately behind the stressing anchorage.

a. Weld a pipe sleeve to the bearing plate and seal the pipe sleeve to the anchor sheath at the other end of the sleeve.
b. Clean the pipe sleeve to remove dirt, rust, or other harmful material before inserting the soil nail into the pipe sleeve.
c. If a seal is not provided at the lower end of the pipe sleeve, during installation and grouting, fill the lower end of the pipe sleeve with grout. Keep the pipe sleeve free of harmful material until the upper portion of the pipe sleeve and anchor head are filled with grout.
d. Fill the void inside the sleeve and anchor head with anti-bleed expansion grout after the nails have been stressed.

3. Anchorage
Encase the anchorage system head into a corrosion protective system before proceeding to the next lift. Install the protective system for each lift within 30 days after installing the nails for that lift. Ensure that the anchorage system has a cover of at least 3 in (75 mm) once the wall face is placed.

628.3 Construction Requirements

628.3.01 Personnel

A. Contractor Qualifications

The Contractor and Subcontractor shall be experienced in constructing permanent soil nailed walls. Provide at least one Registered Professional Engineer licensed to perform work in the State of Georgia and a supervising Engineer for the Project with at least 5 years of experience in constructing permanent soil nailed walls.

Furnish verification of these qualifications to the Engineer before beginning operations.

B. Design Engineer

The Design Engineer shall:

- Be registered as a Professional Engineer in the State of Georgia
- Have considerable knowledge and experience designing and constructing soil nailed walls
- Be available at any time during the Contract to discuss the design of the walls with the Department.

C. Registered Professional Engineer

Retain the services of a second Professional Engineer licensed to perform work in the State of Georgia and prequalified by the Department. The Engineer shall operate independently from the Professional Engineer of Subsection 628.3.01.B, "Design Engineer."

This Engineer will independently check the design calculations and Plan details for the permanent soil nailed wall before submitting them to the Department.

628.3.02 Equipment

Use anchorage and hardware suitable for the type of soil nails used. Ensure that the anchorage and hardware are capable of the following:

- Developing 75 percent of the yield capacity of the nails when tested in the unbonded state and without failure of the nail
- Holding the soil nail at a load producing a stress of not less than 75 percent of the yield capacity of the nail without exceeding the anticipated set and without causing anchorage or soil nail failure
- Test nails shall be capable of lifting-off, detensioning, or retensioning a nail before secondary grouting to fill voids at the top of the pipe sleeve.

628.3.03 Preparation

Before beginning the work, survey the condition of the adjoining properties. Keep records and photograph settlement or cracking of adjacent structures that may become the subject of possible damage claims. Deliver the report to the Department before beginning work at the site.

Obtain a Foundation Investigation Report from the Geotechnical/Environmental Bureau of the Department to assist in evaluating existing conditions for design and construction.

628.3.04 Fabrication

A. Soil Nails

Fabricate the soil nails according to the approved details.

1. Keep the nails free of dirt, rust, and other harmful substances.
2. Use a plastic sheath that is a single piece without splices.
3. Before installation, handle and store the nails so as to avoid corrosion and physical damage. Nails will be rejected for damage such as abrasions, cuts, nicks, welds, weld splatters, or heavy corrosion and pitting. Replace the nails at the Contractor's expense for material replacements or time delays.

628.3.05 Construction

A. Design Criteria

The design criteria for a proposed design or design include:

1. Design soil nails according to this Specification.
2. Use reinforced concrete facing according to the latest AASHTO Standard Specifications for Highway Bridges, including interims. Ensure that the structural thickness is at least 12 in (300 mm). Provide architectural facing treatment as shown on the Department drawings.
3. Ensure that the concrete strength is at least 3000 psi (20 MPa) 28-day strength. Extend the facing 2 ft (600 mm) below the gutterline or, if applicable, the ground line adjacent to the wall unless otherwise indicated on the Department Plans.
4. Design and install permanent drainage systems behind the wall. Connect the drainage systems to the nearest drop inlet using pipe or free drainage through traffic barriers or other obstructions. Ensure that holes through traffic barriers and/or facing are no higher than 3 in (75 mm) above the gutterline or ground line.
5. Ensure that the wall is compatible with the horizontal and vertical criteria indicated in the Department Plans.
6. Provide a wall design that is adequate to resist sliding, overturning and bearing forces. Safety factors shall be as follows:

Sliding	1.50
Overturning	2.00
Bearing	1.00

   Design the wall for the design condition shown in Figure 1.
7. See Figure 3 for typical section of permanent soil nail wall.

B. Ground Movements and Load Transfer Instruments

During construction of the wall, the Department may install devices to monitor ground movements and load transfers during or after construction. The Department will schedule installation to minimize interference with the Contractor's operations. Cooperate with the instrumentation installers. Anticipate delays of two to four hours per instrumented nail.

Although the Instrumentation Specialist maintains the instruments, assume responsibility for damage to the instruments, connections or readouts from operations. Replace and install damaged equipment at the Department's approval and at the Contractor's expense.

C. Soil Nail Installation

Install the soil nails as follows:

1. Before installation, visit the site to observe existing conditions that may affect the work or design, if applicable, and to review the geotechnical data available for the Project.
2. Drive or drill the holes for the soil nails by core drilling, rotary drilling, auger drilling, or percussion drilling. If using water in the drilling operation, dispose of the water to minimize wall erosion. Repair water erosion damage to the site at no cost to the Department.
3. If the hole will not stand open, install casing to maintain a clean and open hole. Ensure that the hole diameter is at least 3 in (75 mm) if no pressure grouting is used. Pressure grouting is grouting with a pressure greater than 60 psi (415 kPa).
4. Ensure that the drill bit diameter is not more than 1/8 in (3 mm) smaller than the specified hole diameter.
5. Start soil nail holes within an angle tolerance of 3 degrees from the inclination specified on the approved design Plans. Do not allow the holes to deviate from a straight line by more than 2 in (50 mm) in 10 ft. (3 m). Do not allow the holes to extend outside the Right-of-Way limits. Thoroughly clean the holes of all dust, grease, or other deleterious material before inserting the nail.
6. Install the nail in the casing or the hole drilled for the nail. Ensure that the nail's corrosion protection is not damaged during handling or installation.
7. Install the nail in the bond length to achieve at least 1½ in (38 mm) of grout cover.
8. Do not use nails to ground electric equipment and do not subject the nails to sharp bends.

9. Provide centralizers spaced a maximum of 5 ft (1.5 m) center to center throughout the nail length. Do not use spacers of wood or other material harmful to the nail or corrosion protection.
10. Inject grout at the lowest point of the nail and place over the entire length of the nail.
    a. Ensure that the grouting equipment can continuously mix and produce lump-free grout. Equip the grout pump nozzle with a grout pressure gauge capable of measuring pressure of at least 150 psi (1 MPa) or twice the actual pressure used.
    b. Base the material proportions used in the grout on grout tests made before beginning grouting; or select the proportions based on prior documented experience with similar materials and equipment under comparable field conditions.
    c. Use the minimum water content necessary for proper placement and do not exceed a water-cement ratio of 0.45. Do not leave the grout in the mixer longer than 45 minutes.
11. After grouting, do not disturb the nail until the grout has reached a cube strength of 3500 psi (25 MPa). Keep the mouth of the hole clean after grouting. Record the following data in a Project field book during the grouting operation:
    - Type of mixer
    - Water-cement ratio
    - Type of additives
    - Grout pressure
    - Type of cement
    - Test sample strengths (before stressing)
    - Volume placed in bond and free lengths
12. If using pressure grouting, choose whether to perform a water-tightness test. However, if injecting grout with a pressure of 60 psi (415 kPa) or less, always perform a water-tightness test. Perform the test as follows:
    a. Fill the entire hole in the rock with water and subject it to a pressure of 5 psi (35 kPa) in excess of the hydrostatic head as measured at the top of the hole.
    b. If after 10 minutes the leakage rate from the hole exceeds 0.001 gal per inch diameter per foot of depth per minute (0.5 ml per mm diameter per meter of depth per minute), consolidate grout, redrill, and retest the hole. If the second water-tightness test fails, repeat the entire process.
    c. During the tests, observe holes adjacent to the hole being tested for water-tightness to detect and seal inter-hole connections.
    d. If artesian or flowing water is encountered in the drilled hole, maintain the pressure on the consolidation grout until the grout has initially set.

D. Temporary Shotcrete Facing

Provide temporary shotcrete facing.

1. Shotcrete Quality - Produce the shotcrete by the wet mix process and achieve a minimum compressive strength of 3000 psi (20 MPa) in seven (7) days and 4600 psi (32 MPa) in 28 days.
2. Mixture Proportions - Submit for acceptance the recommended mixture proportions, strength results, water cement ratio, and source of materials. Select the mixture proportions based on compressive strength tests of specimens continuously moist cured until tested at 28 days in accordance with AASHTO T-22. Use a maximum water cement ratio of 0.40, air content of 6.5% ± 1.5%, slump of 1.5 to 3 inches (38 to 50 mm). The mixture is acceptable if the average core compressive strength is at least 1.2 times the required compressive strength in 628.4.07.A above.
3. Batching and Mixing - Batch aggregate and cement by weight or by volume. Provide mixing equipment capable of thoroughly mixing the materials in sufficient quantity to maintain placing continuity. Provide ready-mix shotcrete complying with AASHTO M-157.
4. Delivery Equipment - Provide equipment capable of delivering the premixed materials accurately, uniformly and continuously through the delivery hose. Follow the recommendations of the equipment manufacturer on the type and size of nozzle to be used, and on cleaning, inspecting and maintaining the equipment. Deliver ready-mix shotcrete in transit mixers that comply with AASHTO M-157. Provide a supply of clean, dry air adequate for maintaining sufficient nozzle velocity for all parts of the work and, if required, for simultaneous operation of a suitable blow pipe for clearing away rebound. Provide a compressor capable of providing a minimum of 315 cfm (8.9 m3/min) per operating nozzle.

5. Curing:
    a. Keep shotcrete continuously moist for 24 hours after completion by one of the following methods or materials:
        - Continuous sprinkling

- Absorptive mat or fabric, or other covering kept continuously moist
- Curing compounds in accordance with Section 500.3.05.Z. On natural gun or flash finishes, apply one gallon per 100 square feet (0.4 l per square meter). Do not use curing compounds on any surfaces against which additional shotcrete or other cementitious finishing materials are to be bonded unless positive measures, such as sandblasting, are taken to completely remove curing compounds prior to application of such additional materials.

b. Provide final curing immediately following the initial curing and before the shotcrete has dried by one of the following materials or methods:
   - Continuation of the method used in the initial curing
   - Application of impervious sheet material conforming to AASHTO M-171.

c. Continue curing for the first seven days after shotcreting or until the required seven-day strength is obtained. During the curing period, maintain the shotcrete above 38 degrees F (3.3 degrees C) and in a moist condition as specified.

6. Construction Testing - Cut cores from the structure and test in accordance with AASHTO T-24. Take a minimum of three cores from each 1000 square feet (93 square meters) of completed facing. Alternatively, construct a test panel with minimum dimensions of 18 X 18 X 4 in (450 X 450 X 100 mm) gunned in the same position as the work represented for each 1000 square feet (93 square meters) of completed facing. The Contractor's regular nozzlemen shall gun the panels during the course of the work. Field cure the panels in the same manner as the work, except that the test panels shall be soaked for a minimum of 40 hours prior to testing. Cut a minimum of three cores from each panel for testing in accordance with AASHTO T-24. The average compressive strength of each core of a set of three cores must equal or exceed 85 percent of the compressive strength specified in 628.3.05.A.

E. Permanent Cast-In-Place Facing

Provide permanent cast-in-place reinforced concrete facing in accordance with the requirements of this specification, as shown in the plans and the following:

1. Provide vertical expansion joints at a maximum spacing of 90'-0"
2. Provide vertical contraction or construction joints at a maximum spacing of 30'-0"
3. Form vertical rustication grooves at a maximum spacing of 10'-0". Rustication grooves are to be equally spaced between expansion joints and coincide with construction joints.
4. Provide studs in the construction of the soil nail system for anchoring the cast-in-place facing.

628.3.06 Quality Acceptance

A. Nail Testing and Acceptance

Perform testing according to this subsection.

Perform load tests on at least 5% of the nails in each row to verify the soil-to-grout bond stress used in the design. Provide separate nails specifically for the purpose of testing. Test nail locations shall be approved by the Engineer. Test nails will not be considered part of the permanent support system. Install the test nails in accordance with Figure 2. Grout only the bonded length of the nail prior to testing. Provide and use the following testing equipment:

- A dial gauge that can measure elongation to the nearest 0.001 in (0.025 mm)
- A hydraulic jack and pump with a pressure gauge graduated in increments of 100 psi (690 kPa) or less.

Test by incrementally loading the nail according to the following schedule:

AL
0.25P
0.50P
0.75P
1.00P
1.25P
1.50P

where:

AL = minimum load required to support the jacking system tightly against the bearing surface = 2 kips (8.9 kN).
P = design load

Measure the nail movement with the dial gauge fixed to an independent reference point. Apply the load with a hydraulic jack and measure it with a hydraulic pressure gauge. Increase the load from one increment to the next immediately after the nail movement is recorded.

Hold the maximum test load for ten (10) minutes. Start the load hold period as soon as the maximum test load is applied, and measure the nail movements at one (1), two (2), three (3), four (4), five (5), six (6), and ten (10) minutes. The nail

test is acceptable if the nail carries the maximum test load with less than 0.08 in (2 mm) of movement between one (1) and ten (10) minutes.

If the nail fails the test, determine the cause. If the failure indicates that the nails will not achieve the design soil-to-grout bond stress, then modify the design and/or construction procedures. These modifications may include, but are not limited to, installing replacement nails, reducing the design bond stress by increasing the number of soil nails or by lengthening the nails, or modifying the installation methods. After modifications, test the nails for acceptance of the new design. Make the modifications of the design and/or construction procedures at no cost to the Department unless the modifications are due to changed conditions.

After completion of testing and determination of acceptance, detension all test nails and all nails shall be tensioned to 200 ft-lb (270 N-m) of torque.

628.4 Measurement

Permanent Soil Nailed Walls are not measured separately for payment.

628.5 Payment

Payment for this work is made per Lump Sum. Payment includes costs for concrete, reinforcing steel, excavation, backfill, shotcrete, soil nails, anchorages, labor, design, and all other materials and equipment. Payment also includes grouting, drilling holes, performing and evaluating all tests, submitting records of tests, all tools and all other items to complete the work.

Payment will be made under:

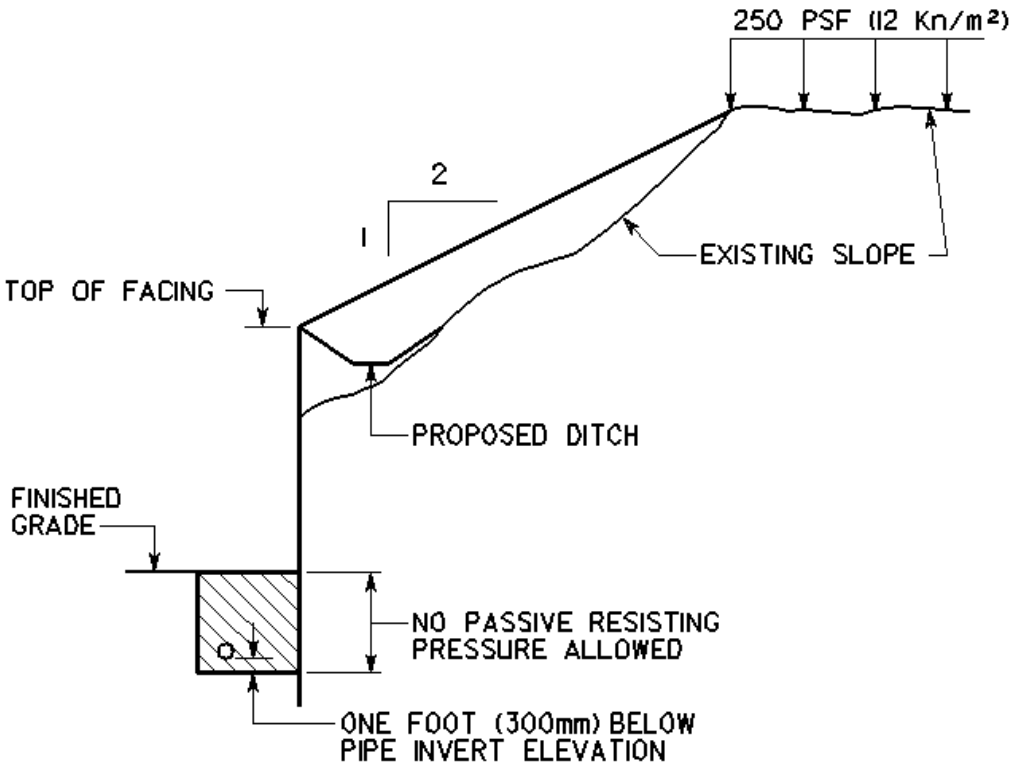
Item 628	Permanent Soil Nailed Wall, wall no. ___	Per lump sum

628.5.01 Adjustments

Additional wall area required because of unforeseen foundation conditions or other reasons that are approved by the Engineer will be paid for by adjusting the Lump Sum Price Bid. If the wall area is increased or decreased, the Lump Sum Price Bid will be adjusted proportionally based on the change in wall area as determined from the stations, elevations and dimensions on the Plans.

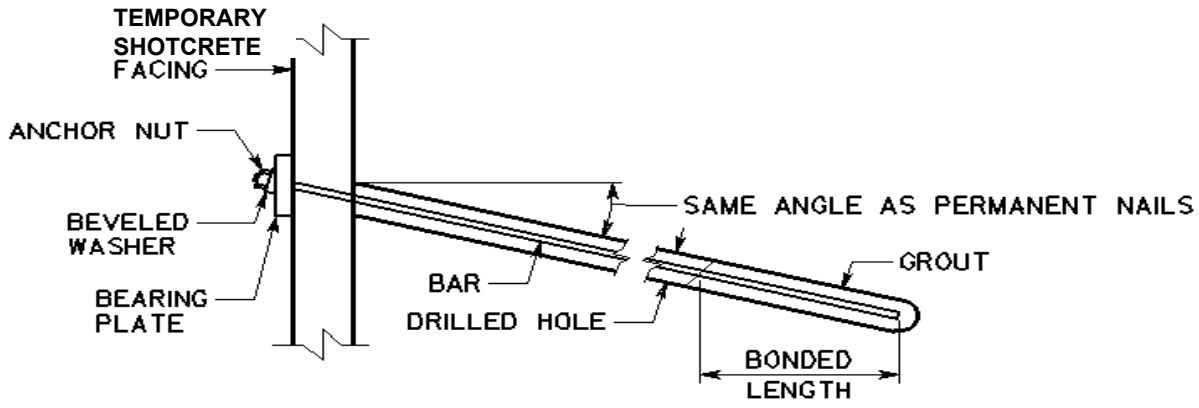
No additional compensation will be made for additional material, equipment, design, or other items to comply with the Project specifications as a result of the Department's review of the contractor's design.

OFFICE OF BRIDGE DESIGN



DESIGN CONDITION

FIGURE 1



TEST NAIL DETAIL

NO SCALE

FIGURE 2

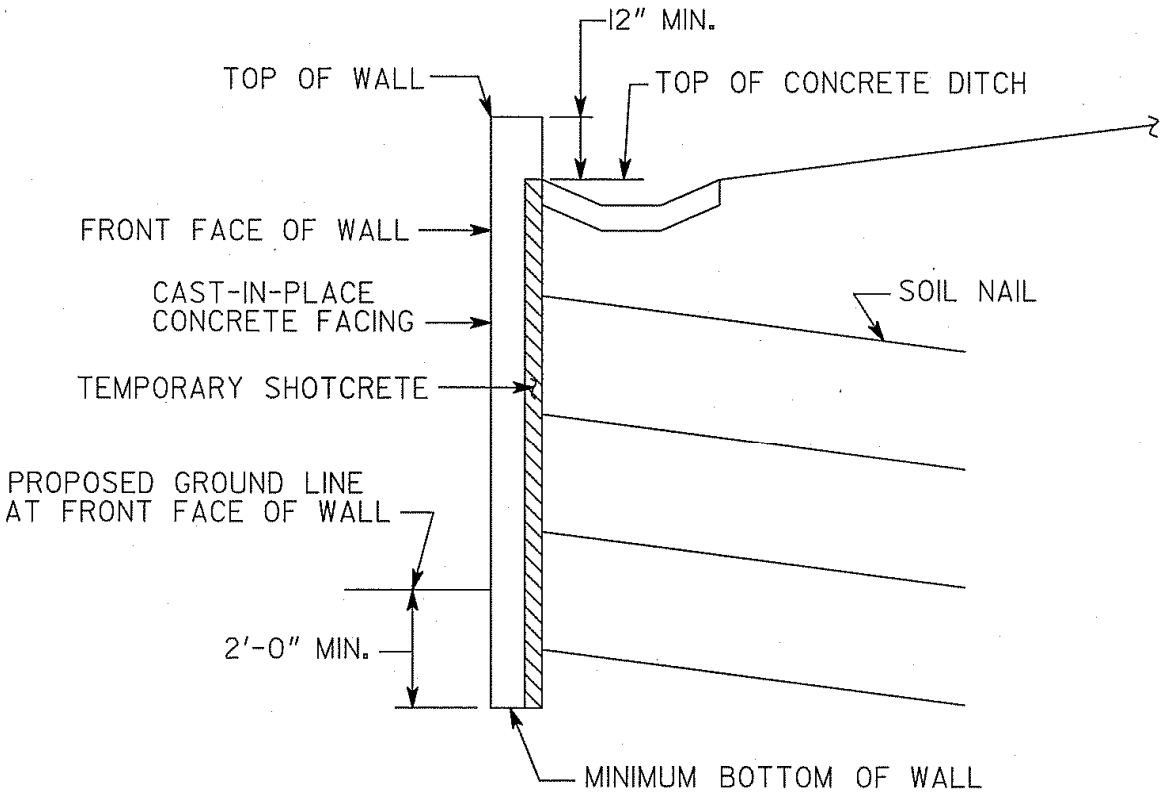

12" MIN.
TOP OF WALL
TOP OF CONCRETE DITCH
FRONT FACE OF WALL
CAST-IN-PLACE
CONCRETE FACING
SOIL NAIL
TEMPORARY SHOTCRETE
PROPOSED GROUND LINE
AT FRONT FACE OF WALL
2'-0" MIN.
MINIMUM BOTTOM OF WALL

FIGURE NO. 3

First Use: March 15, 2013

Updated May 17, 2013

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

PROJECT: XXXXXXX
XXXXXX COUNTIES
P.I. NO. XXXXXXX

SECTION 631 – PERMANENT CHANGEABLE MESSAGE SIGNS

Section 631 - Permanent Changeable Message Signs

631.1 General Description

This Work includes furnishing and installing permanent changeable message sign equipment. Major elements of the CMS system include changeable message signs, sign housing (walk-in or front access), LED modules, LED drivers, power supplies, local changeable message sign controller, roadside CMS cabinet and power service to the controller and sign.

Configure the system to provide motorists with graphics and textual information using changeable message signs placed over or adjacent to designated roadways. Local CMS controllers provide a base level of control of the CMS display. Primary control and command of the local CMS controllers in the system will be through a communication link to a central facility as identified within the project plans. Auxiliary control will be accomplished from other remote locations to the central facility locations, as identified within the project plans, over communication media that may be different than that used for the primary control and command to/from the central facility. Local control and command may be accomplished manually from the local CMS controller by operator input via a keypad on the front of the controller and through the use of a laptop computer connected to one of the data ports of the local CMS controller.

Use only products and materials that meet the requirements of these minimum specifications and are listed on the Department's Qualified Products List. Provide all equipment and materials of like kind and function to be of the exact same manufacture, model, revision, firmware, etc.

631.1.01 Definitions

A. CMS Type 1- Freeway sign with 3 lines of 21 characters (18" – 14x10 font characters) – Walk-in enclosure.

   a. Shall be full matrix (variable text and graphics) sign with minimum of 250 pixel columns and 54 pixel rows.

   b. Pixel Pitch (spacing) shall be 1.33 in (34 mm)

   c. Pixel spacing shall be such that three lines of text (14x10 font characters) shall each have a nominal height of 18 inches.

   d. The sign housing shall be a walk-in enclosure.

B. CMS Type 2 – Freeway sign with 3 lines of 21 characters (18" – 23x15 font characters) – Walk-in enclosure.

a. Shall be full matrix (variable text and graphics) sign with minimum of 400 pixel columns and 96 pixel rows.

b. Pixel Pitch (spacing) shall be 0.81 in (20 mm).

c. Pixel spacing shall be such that three lines of text (23 x 15 font characters) may be displayed each having a nominal height of 18 inches.

d. The sign housing shall be a walk-in enclosure.

C. CMS Type 3 – Freeway sign with 3 lines of 15 characters (18' – 23 x 15 font characters).

a. Shall be a full matrix (variable text and graphics) sign with a minimum of 288 pixel columns and 96 pixel rows.

b. Pixel Pitch shall be 0.81 inches (20 mm)

c. Pixel spacing shall be such that three lines of text (23x15 font characters) shall each have a nominal height of 18 inches.

d. The sign housing shall be a front access enclosure.

D. CMS Type 4 - Arterial sign with 3 lines of 12 characters (7x5 font characters) – Front access enclosure.

a. Shall be a full matrix sign with a minimum of 75 pixel columns and 27 pixel rows.

b. Pixel Pitch shall be 1.75 inches (46 mm)

c. Pixel spacing shall be such that three lines of text (7x5 font characters) shall each have a nominal height of 12 inches.

d. The sign housing shall be a front access enclosure.

E. CMS Type 5 - Arterial sign with 3 lines of 12 characters (15x10 font characters) – Front access enclosure

a. Shall be a full matrix sign with a minimum of 160 pixel columns and 64 pixel rows.

b. Pixel Pitch shall be .081 inches (20 mm)

c. Pixel spacing shall be such that three lines of text (15x10 font characters) shall each have a nominal height of 12 inches.

d. The sign housing shall be a front access enclosure.

631.1.02 Related References

A. Georgia Standard Specifications

Section 150 – Traffic Control

Section 682 – Electrical Wire, Cable, and Conduit

Section 925 – Traffic Signal Equipment

Section 939 – Communication and Electronic Equipment

Section 940 – NaviGAtor Advanced Transportation Management System Integration

B. Referenced Documents

AASHTO "Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals"

American National Standards Institute (ANSI)

American Society of Testing and Materials (ASTM)

American Welding Society (AWS) Standards

Electronic Industries Association (EIA)

Illumination Engineers Society (IES)

International Municipal Signal Association (IMSA)

ANSI/IPC-T-50, latest version/addendum

MIL-P-13949, latest version/addendum

IPC-2221. latest version/addendum

IPC-D-275, latest version/addendum

MIL-PRF-31032, latest version/addendum

National Electrical Code (NEC)

National Electrical Manufacturers Association (NEMA)

NEMA TS-4, 2004,

National Transportation Communications for ITS Protocol (NTCIP)

Rural Electrification Administration (REA)

Underwriters Laboratory Incorporated (UL)

C. NTCIP References

This Specification references several NTCIP standards. Each NTCIP Component covered by these Specifications shall implement the most recent version of the standard that has reached the stage of Recommended or higher as of September 20, 2004, including any and all Approved or Recommended Amendments to these standards as of the same date.

The standards that have been referenced by this Specification are listed below.

NTCIP Number	Title
NTCIP 1201:1996	NTCIP Global Object (GO) Definitions
NTCIP 1203:1997	NTCIP Object Definitions for Dynamic Message Signs (DMS)
NTCIP 2001:1996	NTCIP Class B Profile
NTCIP 2101 v01.17	NTCIP SP-PMPP/RS232 (Point-to-Multi-Point Protocol using RS232 Sub-network Profile)
NTCIP 2103 v01.05	NTCIP SP-PPP/RS232 (Point-to- Point Protocol using RS232 Sub-network Profile)
NTCIP 2104	NTCIP SP-Ethernet (Ethernet Profile)
NTCIP 2201 v01.03	NTCIP TP-Transportation Transport Profile (TP-Null)
NTCIP 2202	NTCIP TP-Internet (TCP/IP and UDP/IP)
NTCIP 2301 v01.07	Simple Transportation Management Framework (STMF) Application Profile

Note that the last four documents reflect the current trend of the NTCIP standardization effort to define profiles that relate to particular protocol levels in the NTCIP Framework. A protocol stack defined in accordance to NTCIP 2101, NTCIP 2201, and NTCIP 2301 directly corresponds to the protocol stack defined in NTCIP 2001.

631.1.03 Submittals

Use only products and materials that meet the requirements of these minimum specifications and are listed on the Department's Qualified Products List. Products appearing on the Qualified Products List (QPL) are exempt from normal submittal requirements. These products have been evaluated by the Office of Traffic Operations and have proven their capability of meeting the appropriate Georgia Department of Transportation Specification. Any of these products may be used without submitting catalogue cuts, sampling or pre-testing. The Contractor shall submit a letter to the Field Engineer, stating which QPL items they will use. The Field Engineer and/or department designee must ascertain that the construction item is the same material identified on the appropriate QPL and will acknowledge receipt of these items in the project diary or as required by the Construction manual.

The following chart provides the Contractor with an outline of the submittal requirements for the equipment and components for these pay items. This chart is to be used as a guide and does not relieve the Contractor from submitting additional information to form a complete submittal package.

The following definitions apply to the submittal requirement terms in the following chart:

Shop Drawings: Drawings providing detailed assembly and component layout, used by the manufacturer to assemble or construct the Item.

Structural Calculation: Calculations prepared by a registered Professional Engineer, in the state of Georgia, that indicate that the assembly meets all requirements of this specification, the Standard Specifications and AASHTO for wind loading, etc.

Lab Test Report: A certified report from an independent laboratory that the component or assembly meets all the requirements of this specification.

Installation Procedure: A manual prepared by the manufacturer that indicates the installation procedures for components, sub assemblies or assemblies as outlined in Section 631.1.03 C of this specification.

Maintenance Procedure: A manual prepared by the manufacturer that indicates the maintenance of all components, sub assemblies, and assemblies as outlined in Section 631.1.03 M2 of this specification.

Test Schedule: A written schedule of the testing required as outlined in Section 631.1.03 C of this specification.

Test Plan: A plan developed by the manufacturer to perform the testing required for this item as outlined in Section 631.1.03 F, G, and H, and Section 631.3.06 F1, F2, F3, and F4 of this specification.

Test Reports: A report developed by the manufacturer that documents the results of each of the required tests as outlined in Section 631.3.06 F1 of this specification.

Training Schedule: A schedule prepared by the Contractor that outlines the time for the required training sessions as outlined in Section 631.3.08 A, of this specification.

Training Material: Course material for each of the training sessions required by Section 631.3.08 of this specification.

Material	Specification Reference	Catalog Cuts	Mfg. Spec.	Shop. Drawings	Structural Calc.	Lab Test Report	Install. Proced.	Maint. Proced.	Test Schedule	Test Plan	Test Reports	Training Schedule	Training Material	Submittal Due Date (Calendar Days After NTP)
Pre-Installation Test	631.3.06 F.2								x	x	x			Plan - 60 Days
Proof of Performance Test	631.3.06 F.3								x	x	x			Plan - 60 Days
Acceptance Test	631.3.06 F.4								x	x	x			Plan - 60 Days
Training	631.3.08 A											x	x	Plan - 90 Days

A. General

Clearly identify in the submittals any deviations from the Contract requirements and Specifications. Provide a detailed description of the deviation with the reason for the change. Do not interpret approval of the submittals or shop drawings as approval of any deviation unless such deviation is identified in writing in the submittal letter that is separate from the shop drawings.

B. As-Built Plans

Furnish four (4) complete half-size 11" x 17" as-built plans signed and sealed by a Professional Engineer registered in the State of Georgia in accordance with the Standard Specifications. Include in the as-built plans all materials and installation work, along with all structural elements and assemblies that are related to the CMS system at a given location. Prepare the as-built plans and show in them all changes and deviations from the original Plans. On each plan sheet, provide the name of the Contractor and any Subcontractors who performed any work shown on the plan sheet. Submit the as-built plans to the Engineer no later than 30 days after the completion of acceptance testing. The burn-in period will not commence until the Engineer approves the as-built plans.

C. Submittal Data Requirements

Submit submittal data and shop drawings for all equipment, materials, test procedures, and routine maintenance procedures required in this Contract within 60 calendar days after Notice to Proceed and prior to any installation, unless noted otherwise in the Contract documents. Submit available third party test results for required items shown in Pre-Installation Testing. Submit structural foundation, support, and mounting shop drawings for changeable message signs within 90 calendar days after Notice to Proceed.

Submit to the Engineer for approval, two (2) hardcopies and one electronic copy of the manufacturer's descriptive literature, technical data, operational documentation, service documentation, and other materials fully describing the design, equipment, and materials that will be used for all non-structural equipment or materials required in this Specification.

Provide shop drawings for all structural support materials, changeable message sign housing material, and all other special design, non-electrical, non-mechanical fabricated items.

Provide submittal data and shop drawings that are neat, legible, and orderly. Neatly organize each package of submittal data and separate by hardware item. Use the “Material Certification Package Index and Transmittal Form,” contained in Section 105.02 of the standard specifications, for each pay item to document and list all material and components that are included in the submittal package. Any submittal data submitted without the Index/Transmittal form or that is incomplete will be rejected.

Light output of the individual LED pixels shall be in accordance with NEMA TS-4. The manufacturer shall submit third party documentation of compliance.

D. Submittal Review Demonstration Test Set

Submit demonstration test set(s) for Department evaluation after the Engineer approves the submittal materials for the equipment and materials listed below. The demonstration test sets shall be connected to and operated through the NaviGAtor system by the Engineer. Deliver the test set to the Department at the location specified by the Engineer. Request a delivery and test time a minimum of 30 days in advance. Provide demonstration test sets of the materials, types and quantities as shown below:

- CMS Controller, (quantity 2)
- CMS Test Display Simulator, if needed (quantity 1 for each controller required)

A demonstration test set shall include all materials, components, assemblies, control software and documentation of the CMS controller of a CMS and shall be complete and fully functional for communications with the NaviGAtor system. The CMS controller and test display simulator shall be configured for locating on a bench top, or else provide a desktop stand to secure the equipment. A CMS test display simulator shall be provided if necessary for full communications with the CMS controller from NaviGAtor, including sign display and pixel status monitoring and dimming operation. The CMS test display simulator is only for use during the demonstration test period and remains the property of the Contractor. Provide a power supply for the CMS controller and display simulator that operates from 120VAC with a NEMA 5-15 cord. Provide RS232 cables for connection of the RS232 communications port(s) on the CMS controller.

Review of the demonstration test set submittal shall be conducted in two parts. The first part of the review shall be performed by the Contractor in the presence of the Engineer and shall include the setup and configuration of the demonstration test set on the NaviGAtor system. The first part of the review shall be conducted during normal Department weekday business hours and shall be conducted for the period of time necessary to the satisfaction of the Engineer. The second part of the review shall be a 60-day period during which the Engineer shall operate and evaluate the demonstration test set with the NaviGAtor system. The second part of the review shall commence only upon the Engineer's approval of the first part of the review. Retrieve the demonstration test set upon completion of the second part of the review as notified by the Engineer.

E. CMS Test Software

Within 90 days of Notice to Proceed, submit for Department review proposed CMS test software that will be used to verify the functional and performance capabilities of the CMS using the NTCIP protocol stack. The review of the test software will not relieve the Contractor of any requirements to provide a fully functioning CMS that performs in accordance with the Specifications.

F. Documentation for Electronic Equipment

Provide the documentary items specified in this section for all changeable message sign equipment and materials. The documentary items shall provide a complete and precise technical description of all CMS equipment and materials and shall thoroughly demonstrate that the design and construction of all CMS equipment and materials fully conforms to all requirements of this Specification.

Provide the following documentary items in a neat, legible, clearly identified, and suitably bound fashion:

- Manual fully describing the theory of operation with complete technical data including block diagrams showing operational relationships between major components, wave forms, etc.
- Manual for troubleshooting including flowcharts, test procedures, test points, alignment procedures, etc.
- Electronic schematics on 11" x 17" drawings.
- Pictorial layout of components on circuit boards showing locations of all components and referencing each component to its entry in the parts list/manufacturer's data sheet.
- Complete parts lists/manufacturer's data sheets of all passive and active electrical and electronic components. Parts lists/data sheets shall provide complete technical materials and performance data, environmental specifications, manufacturer's names/part numbers, etc.
- Drawings and materials lists of all equipment and assembly frames, mounting brackets, mechanical items, etc.
- Diagrams of field installation wiring showing all terminal block positions and identifications.
- Recommended routine maintenance procedures and schedules for all equipment and materials.

G. Pre-Installation Testing

Submit the Pre-installation Test Plan in accordance with this specification. The Pre-Installation Test Plan shall be a detailed and thorough procedure that fully demonstrates that the changeable message sign, local CMS controller, and local CMS controller cabinet meet all requirements of the Specifications. Include the following items within the Pre-Installation Test Plan as a minimum:

- Review of updated documentation.
- Review of updated schematics and drawings.
- Review of electrical design, components, and construction of CMS assembly.
- Review of mechanical design and construction of CMS assembly.
- Operational performance testing of CMS assembly.
- Environmental testing of CMS assembly (may be submitted as third party testing in submittal section C).

- Software functional testing of CMS assembly from local computer.
- Operational test for a continuous 24 hour period.

Request a Pre-Installation Test for one or more signs in writing a minimum of 30 calendar days in advance of the requested test session date. Permit the Engineer to adjust the proposed schedule of the Pre-Installation Test by up to seven (7) calendar days to allow for availability of Department representatives.

H. Proof of Performance Testing

Submit a Proof of Performance Test Plan in accordance with this specification. The Proof of Performance Test Plan shall be a detailed and thorough procedure that fully demonstrates that the complete changeable message sign installation and all work required in the Plans and Specifications at that location meet all Contract requirements. Include with these requirements testing of the following items as a minimum:

- Verification of installation as per the Plans and Specifications, including construction, structural installation, guardrail installation, landscaping, grounding system, and utility installation
- Verification of identical components as installed to those used at the conclusion of pre-installation testing
- Operational performance testing of CMS assembly, including visibility testing, communications testing, display alignment, and workmanship items as per the Plans and Specifications
- Functional testing from local computer
- 48-hour operational testing

Request a Proof of Performance Test for one or more signs in writing a minimum of 15 calendar days in advance of the requested test session date. Permit the Engineer to adjust the proposed schedule of the Proof of Performance Test by up to seven (7) calendar days to allow for availability of Department representatives.

I. Acceptance Testing

Submit an Acceptance Test Plan in accordance with this specification. The Acceptance Test Plan shall be a detailed and thorough procedure that fully demonstrates that the complete changeable message sign system and all work required in the Plans and Specifications meet all Contract requirements. Include in these requirements testing to demonstrate that all changeable message signs can be operated simultaneously as an integrated system. The Acceptance Test Plan shall include a method to verify that all operational items for each CMS can be controlled from a central control facility using the Department's NTCIP communication software and verified by field observation and status response messages.

Request an Acceptance Test in writing a minimum of 15 calendar days in advance of the requested test session date. Permit the Engineer to adjust the proposed schedule of the Acceptance Test by up to seven (7) calendar days to allow for availability of Department representatives.

J. Burn-In Period

Request in writing to begin the burn-in period at least seven (7) calendar days in advance of requested burn-in commencement, but no less than 15 calendar days after successful completion of the following requirements:

- All CMS work required in all Contract documents (may be combined with construction contract) has been completed and inspected by the Engineer (except this burn-in period).
- All Acceptance Testing is successfully completed.

Furnish written reports to the Engineer of the nature, date, and time of all malfunctions, the nature of the repair or corrective action, and the description of any replaced components by equipment and the equipment serial and model numbers. Complete all corrective action within the time defined within these Specifications.

K. CMS Support

Clearly identify in writing the designated contact person and alternate for support and warranty liaison with the Department. Failure to fully comply with the warranty and contractor support described in Subsection 631.3.07.A to the satisfaction of the Department shall be sufficient reason to disqualify the sign manufacturer from bidding on future CMS procurements.

L. CMS Controller

Submit to the Construction Project Manager six copies of the Technical Specifications for the CMS controller unit as specified in Subsection 631.3.04.D. This submission shall include all information for the Department to determine the acceptability of the controller related to construction of the internal components, PCB construction, enclosure construction, power supply construction and capabilities, and operational characteristics and environments for construction and environmental tolerance of the CMS controller.

M. Documentation

Provide three sets of documentation for all components in accordance with these Specifications. Assemble the documentation in volumes of 3-ring binders and include title pages, indexes, page numbering and section dividers.

The documentation shall consist of the following types of manuals:

1. User's Manuals

Describe in the User's Manual how to operate the particular type of equipment, layout of controls, displays, and all other information required to correctly operate a fully functional unit.

2. Operation and Maintenance Manuals

Provide an Operation and Maintenance Manual(s) for the CMS and for the CMS controller unit. Include in the manual(s) all the information required to maintain and repair the equipment to the component level. Provide sections which completely describe the theory of operation using block diagrams and schematic drawings, diagnostic and repair procedures for corrective maintenance of the unit; assembly and disassembly instructions and drawings, layout drawings showing location of all components; and complete components listing showing component type, ratings and acceptable manufacturers. Provide complete schematic diagrams to the component level. The Operation and Maintenance Manual shall fully describe all adjustments and alignment procedures and provide descriptions of expected signals at all test points and outputs. Provide a repair and troubleshooting decision tree that describes each function, a series of tests of each function, and an "if it does this, do that" process that defines faulty elements that require repair, replacement, or adjustment to restore operation of a malfunctioning sign or system element. Provide detailed operating specifications of equipment performance.

3. System Documentation Manual

The System Documentation Manual shall describe the overall operation of the equipment with block level diagrams. Identify all equipment in the system with module and option numbers. Give a functional description of each element of the system and explain how they function together in a complete system. Provide operating procedures describing the initial turn-on, adjustments to ensure that the system is operating within the performance requirements, and system level corrective maintenance procedures.

4. Software Manual

Documentation included within the Software Manual shall include descriptions and listings required to describe the complete operation of all software programs.

5. MIB Documentation Manual and Disk

Provide full documentation of the Management Information Base (MIB) that is used in the CMS controller. Specify the MIB in Abstract Syntax Notation 1 (ASN.1) format, and provide a copy of the MIB specified in ASN.1 in electronic format. The CMS controller must support mandatory objects as indicated by the Standard MIB. If the CMS controller does not support the full range of any object of the Standard MIB, then provide a custom MIB in ASN.1 format that specifies the supported ranges and includes meaningful description fields.

The manufacturer shall allow the use of any and all of this documentation by any party authorized by the Department for systems integration purposes or for use in NaviGAtor software at any time initially or in the future, regardless of what parties are involved in the systems integration effort.

N. Working Drawings

Submit working drawings to the Engineer no later than 30 calendar days after the Notice to Proceed. Include in the working drawings a pictorial representation of the assemblies that form a complete CMS system, the connection and wiring between assemblies, switch and adjustable control settings, and a description of the functionality of the assemblies including a listing of the assemblies required to form a complete CMS system.

O. Training Material

Provide each training participant with a copy of course material. Include in course material copies of both a comprehensive manual and of the presentation material that will be used. Provide two (2) additional copies to the Department. Provide the classroom, audio-visual equipment, demonstration equipment and "hands-on" equipment required.

Provide a draft of the course material to the Engineer who will approve or reject the course material or content within three (3) weeks of receipt.

631.2 Materials

A. General

Furnish only new equipment that conforms to the applicable requirements of the Underwriters Laboratory Incorporated (UL), the Electronic Industries Association (EIA), the National Electrical Code (NEC), the American Society of Testing and Materials (ASTM), the American National Standards Institute (ANSI), International Municipal Signal Association (IMSA), the National Electrical Manufacturers Association (NEMA), Rural Electrification Administration (REA), Illumination Engineers Society (IES), American Association of State Highway and Transportation Officials (AASHTO), American Welding Society (AWS), and the applicable Standards, Specifications, and Regulations of the Georgia Department of Transportation and to any other codes, standards, or ordinances which may apply. Whenever reference is made to any of the standards mentioned, consider the reference to mean the code, ordinance, or standard that is in effect at the time of the bid advertisement. Where conflicts occur between any of the Specifications defined above and this specification, this specification shall prevail.

B. Components

1. General

Specific components used in any subassembly of the CMS shall be of the highest quality, industrial grade or MIL Spec. available consistent with the design of the equipment or subassembly.

2. Wiring, Cabling, and Harnesses

Ensure that all electrical conductors are stranded copper. Harnesses shall be properly bundled and tie-wrapped with external protection. Ensure that each harness is of adequate length to allow any conductor to be connected properly to its associated connector or termination point.

C. Mechanical

1. Pin and Socket Connectors

Provide pin and socket connectors per IPC Standards..

D. Laptop Computer

Provide a laptop computer for testing that will run the testing software as specified in Subsection 631.3.06.F. The laptop computer shall remain the property of the Contractor after the completion of all CMS testing.

631.2.02 Delivery, Storage and Handling

Not applicable

631.3 Construction Requirements

631.3.01 Personnel

Not applicable

631.3.02 Equipment

Not applicable

631.3.03 Preparation

Not applicable

631.3.04 Fabrication

A. Components

1. General

Use only electrical/electronic components that are of modular, interchangeable, plug-in type fabrication and are standard manufacturers' components and UL certified. The design shall be such that a single pixel driver board failure will not effect more than the light emitting modules directly controlled by the failed driver board. During replacement of defective driver boards or light emitting modules, ensure that the sign remains operational but need not display messages as defined within the failure modes described elsewhere in these Specifications.. All DMS shall have third party NEMA TS4 section 2 Environmental Testing.

2. LED Display Modules

The CMS shall contain LED display modules that include an LED pixel array and LED driver circuitry. These modules shall be mounted adjacent to one another in a two-dimensional array to form a continuous LED pixel matrix. Each LED display module shall be constructed as follows:

a. Each LED display module will consist of one circuit board. The header connections shall be constructed so that the boards cannot be connected incorrectly.

b. All LED modules shall be manufactured using laminated fiberglass printed circuit boards designed to IPC Standards.

c. Each LED display module shall be mounted to the rear of the display front face panel(s) using durable non-corrosive hardware. No tools shall be required for module removal and replacement. The modules shall be mounted such that the LEDs emit light through the face panels such that the face panel does not block any part of the viewing cone of any of the LEDs in the pixel. No light enhancing lenses shall be used to achieve viewing angles.

d. LED display module power and signal connections shall be q quick-disconnect locking connector type. Removal or replacement of a display module, or a pixel board or a driver circuit board from its display module shall not require soldering.

e. Removal or failure of any LED module shall not affect the operation of any other LED module or sign component. Removal of one or more LED modules shall not affect the structural integrity of any part of the sign.

f. It shall not be possible to mount an LED display module upside-down or in an otherwise incorrect position within the CMS display matrix.

g. All LED display modules, as well as the LED pixel boards and driver circuit boards, shall be identical and interchangeable throughout the CMS.

3. CMS LED Pixels

a. Each LED module shall contain a printed circuit board to which LED pixels are soldered. The LED pixel matrix shall confirm to the following requirements:

- Each LED module shall contain a minimum of 45 LED pixels configured in a two dimensional array. The pixel array shall be a minimum of nine (9) pixels high by five (5) pixels wide.
- For CMS Type 1, the distance from the center of one pixel to the center of all adjacent pixels, both horizontally and vertically, shall be 1.33 inches (34 mm). For CMS Type 2, 3 and 5 the distance from the center of one pixel to the center of all adjacent pixels, both horizontally and vertically, shall be 0.81 inches (20 mm). For CMS Type 4, displaying 12" characters, the pixel spacing shall be 1.75 inches (46 mm).
- Each pixel shall consist of a minimum of one (1) independent string of discrete LEDs for each color. All pixels shall contain an equal quantity of LED strings.
- The failure of an LED string or pixel shall not cause the failure of any other LED string or pixel in the CMS.
- Each pixel shall contain the quantity of discrete LEDs needed to output white colored light at a minimum luminous intensity of 12,400 candelas per square meter when measured using a photometric meter through the CMS front face panel assembly. Failure to conform to the requirements will be cause for rejection.
- Each pixel shall also be capable of displaying amber colored light with a minimum luminous intensity of 7,440 candelas per square meter when measured using a photometric meter through the CMS front face panel assembly. Failure to conform to the requirement shall be cause for rejection.
- The circular base of the discrete LEDs shall be soldered so that they are flush and parallel to the surface of the printed circuit board. The longitudinal axis of the LEDs shall be perpendicular to the circuit board.

b. Discrete LEDs - All LED shall have a nominal viewing cone of 30 degrees with a half-power angle of 15 degrees measured from the longitudinal axis of the LED. Viewing cone tolerances shall be as specified in the LED manufacturer's product specifications and shall not exceed +/- 5 degrees. The use of optical enhancing lenses to change the angle of viewing is not allowed and shall be cause for rejection.

- Red LEDs shall utilize Aluminum Indium Gallium Phosphide (AllinGaP) semiconductor technology and shall emit red light that has a peak wavelength of 615-635 nm
- Green LEDs shall utilize InGAN semiconductor technology and shall emit green light that has a peak wavelength of 520-535 nm
- Blue LEDs shall utilize InGaN semiconductor technology and shall emit blue light that has a peak wavelength of 464-470 nm
- The LED packages shall be fabricated from UV light resistant epoxy.
- The LED manufacturer shall assure color uniformity and consistency on the LED display face within the 30 degree cone of vision. Inconsistent color shifts or intensity will be cause for rejection.
- All LEDs used in all CMS provided for the contract for which this specification has been provided shall be from the same manufacturer and of the same part number, except for the variations in the part number for color and intensity.
- The LEDs shall be rated by the LED manufacturer to have a minimum lifetime of 100,000 hours of continuous operation under field conditions while maintaining a minimum of 50% of the original brightness. Field conditions shall include operating temperatures between -30 degrees F and + 165 degrees F (-34º and +74º C).

B. Mechanical

1. Connectors

Verify that all connectors are keyed to prevent improper insertion of the wrong connector or PCB.

The mating connectors shall be designated by the connector number and male/female relationship such as CAP (plug or PCB edge connector) and CAS (socket).

2. PCB Assemblies

a. Design: Ensure that all assemblies are easily replaceable and incorporate plug-in capability for their associated devices or PCBs Use only silk screened PCBs that show all component locations and are identified as such by markings matching the drawings and schematics.

Permanently mark the manufacturer's name or logo, model number, serial number, and circuit issue or revision number on the PCB. Make all identification readily visible.

b. Workmanship: Perform all workmanship in accordance with the highest industry standards.

c. Hardware: Unless otherwise noted, use stainless steel hardware in electronic assemblies.

d. Printed Circuit Boards

Definitions: For the purpose of this subsection on PCBs, use design standards taken from ANSI/IPC-T-50, latest version/addendum.

PCB design shall be such that components may be removed and replaced without damage to boards, traces, tracks, or other components mounted on the board.

e. Soldering: Hand solder in compliance with Military Specification: MIL-PRF-31032, latest version/addendum.

Perform automatic flow soldering in accordance with EIA standards.

C. CMS

This subsection describes the minimum requirements for the CMS assembly including the following major subassemblies:

- Sign housing and mounting hardware
- Sign face
- Display matrix
- Driving electronics
- Photosensor control
- Environmental control and protection
- Associated cables and wiring

1. Sign Housing

a. Design: Provide a CMS housing structural frame constructed with aluminum extrusions made from 6061-T6 and/or 6063-T6 aluminum alloy. The sign housing shall be constructed of 0.125-inch (3.17 mm) thick aluminum sheeting made from 5052-H32 aluminum alloy. Provide the CMS housing with a minimum of two lifting eyes to be used when placing the housing on the sign structure. Each lifting eye shall attach directly to the DMS housing structural frame and shall have sufficient structural strength to allow the sign to be lifted or moved without damage or deformation to any part of the sign. The sign housing shall be designed to allow mounting angles up to +/- 3 degrees from the vertical or, the front face of the CMS may be constructed with a permanent forward tilt angle of three(3) degrees, so that the top of the CMS housing is deeper than the bottom. The sign housing frame, exterior metal work, supporting structure attachment, catwalks, and lifting eyes assembly shall be certified by a Georgia registered structural engineer provided by the Contractor.

Use high strength aluminum alloy or stainless steel external mounting assembles (including clamps and all associated brackets) conforming to the diameter of the sign support truss beams. Provide all internal and external assembles with stainless steel bolts, washers and stainless steel nuts with nylon inserts. The clamping mechanisms shall be capable of mounting the sign on an overhead truss or bridge structure with an adjustment of the attachment angles. Adjustments to the position of the sign housing cannot require the removal of the housing from the supporting structure in order to align the housing into a different position.

The housing shall conform to the latest AASHTO publication entitled “Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals”. All sharp edges and corners shall be rounded.

Fabricate all CMS housings to present a clean, neat appearance. Protect the equipment located within the sign housing from moisture, dust, dirt, vehicle exhaust fumes, and corrosion.

Provide corrosion protection between dissimilar metals.

b. Welding: The CMS housing shall be welded and inspected in accordance with the requirements of *ANSI/AWS D1.2 Structural Welding Code-Aluminum*.

c. Housing Finish: All surfaces other than the front of the sign housing shall have a bare aluminum mill finish. All visible surfaces of the front face shall be entirely black except for the sign face perimeter strip. Include on the perimeter of the housing a 2 in. (50 mm) wide strip of retro-reflective fluorescent sign material; Amery Fasign (color: Chartreuse) or 3M Scotchcal (color: Saturn Yellow), or approved equivalent.

d. Housing Access: The housing shall be either walk-in or non-walk-in as identified on the Plans. For the non-walk-in housing, permit front access to modules, wiring, and internal components for maintenance purposes. Provide all walk-in housings with replaceable component access from the inside of the sign, excepting the sign face, and other miscellaneous items external to the sign housing.

e. CMS Platform and Housing Door: Provide all front access CMS signs with a suitable cat walk on the front of the sign housing. Include with all walk-in CMS sign housings a 4 ft. (1.2 m) wide or greater cat walk that extends from the right or left shoulder support structure, as defined in the plans, flush with or extending underneath the sign enclosure. Provide fold-down safety rails as a part of the catwalk. Provide a catwalk that will support at least 2,000 lbs. (907 kg) with no discernible displacement. All walk-in CMS sign housings shall provide for all display module and associated electronic and electrical maintenance, replacement, and field repair from the inside of the housing. External repair of the housing and sign face shall be the only items requiring access to the external portions of the housing.

Provide walk-in housings with a minimum 2.5 ft. (0.76 m) by 6 ft. (1.8 m) opening that is dust and moisture tight, lockable, with external and internal stainless steel lever handled door latch system. Ensure that the door latch system can be locked, unlocked, opened, or closed from either the outside or inside of the housing. Ensure that the door latch system does not require a key to lock, unlock, or open the door from the inside of the housing. The outside lock shall be a swing cover, plated brass, tumbler type that is designed for outdoor “no freeze up” applications. Use a No. 2 Corbin key. Provide hold open braces and door stops that allow the door to be held in the full, 90, 45, or 30 degree open positions without the use of tools. Use hold open braces, doors, and hinges designed to withstand a minimum of 40 MPH (64 km/hr) winds while the door is held in any of these positions.

Provide walk-in housings with lighting and duplex receptacles: On the interior of the walk-in sign housing, provide a circuit breaker protected, shielded, fluorescent lighting system to allow maintenance personnel ample working light during day or night maintenance or repair conditions. Activate the light by a timer switch located on the inside of the housing near the door. The light switch timer shall begin timing a “lights on” condition of two hours upon activation of the switch. Turning the switch off and back on will reset the time out to another two hours from the time of the off-on cycle of the switch. Upon time out of the two hour period, the switch shall deactivate the fluorescent lighting by disconnecting the 120 VAC ungrounded circuit from the light. Use a circuit breaker to protect two separate duplex 120V ground fault interrupter (GFI) receptacles that are provided on each end of the sign case for the use of maintenance personnel. Use receptacles rated for 15 amperes. Each receptacle shall be fed from a 15 ampere nominal 120 VAC circuit.

f. CMS Weight and Dimension: Total weight, including all internal and external components for walk-in signs, cannot exceed 3400 lbs. (1542 kg) for signs fifteen characters wide or less and 4100 lbs. (1859 kg) for signs greater than fifteen characters wide.

Individually limit the maximum outside dimensions, excluding minor appurtenances, of the sign to the following.

- Width 31 feet (9.44 m)
- Height 10 feet (3.3 m)
- Depth 4.5 feet (1.4 m)

Limit the power consumption to 4000 watts for signs fifteen characters wide or less and 6000 watts for the signs greater than fifteen characters wide, with all pixels, fans, heaters, and auxiliary equipment operating at their maximum output setting.

g. Hardware Material: Use stainless steel hardware unless otherwise specified. Use nylon friction washers.

h. Maintenance Safety Tie-offs or Anchor Points: Supply the sign with OSHA compliant anchor eyebolts for the connection of a personal fall arrest system. These anchorages must be strong enough to withstand a force of 5,000 pounds (22.2 kilonewtons) as required by OSHA. The anchorages must be located such that they will not allow a person to free-fall more than 6 feet when a 6 foot lifeline is used.

2. Sign Face

The front face of the CMS shall be constructed with multiple rigid panels, each of which supports and protects a full-height section of the LED display matrix. The panels shall be fabricated aluminum sheeting on the exterior and polycarbonate sheeting on the interior of the panel. The aluminum mask of each panel shall contain openings for each pixel that are large enough to not block any portion of the viewing cones of the LEDs.

The front face panels (and the borders of the front face of the sign) shall be coated with semi-gloss black Kynar 500 resin or equal, which has an expected outdoor service life of 10 to 15 years.

The sign face panels shall be attached to each other using stainless steel hardware. Seams separating the panels shall be sealed. The panels shall be mounted in a way so that they are removable from the interior of the sign for walk-in structures and from the outside of the sign for front access signs. The panels shall not be welded or otherwise permanently mounted to the CMS housing.

Each face panel shall have a single polycarbonate sheet attached securely to the inside of the aluminum panel to cover and seal the face to prevent water and other elements from entering the sign. The polycarbonate shall contain UV inhibitors that prevent premature aging of the material and to protect the LED display matrix from the effects of ultraviolet light exposure. A plastic lens system to replace the polycarbonate sheet is not acceptable.

The LED display modules shall mount to the inside of the DMS front face panels.

3. Display Matrix

a. Spacing: The CMS shall contain a full display matrix with the rows and columns of pixels as described in this specification for the sign type specified in the plans. The matrix shall display messages that are continuous, uniform, and unbroken in appearance to the motorists using the roadway approaching the sign location. For sign types 1, 2 and 3, the pixel matrix shall be capable of displaying alphanumeric 18” (460mm) high characters in accordance with the definition defined by NEMA TS 4 Hardware Standards for Dynamic Message Signs Standards. For Type 4 and 5 signs, the pixel matrix shall be capable of displaying alphanumeric 12” (308mm) high characters. The CMS shall be able to display messages composed of an combination of alphanumeric text, punctuation symbols, and graphic images across multiple frames. Each display pixel shall be composed of multiple red, green and blue LEDs. Other pixel technologies shall not be accepted.

b. Display Visibility: Ensure that the sign display is clearly visible and legible from distances between 150 ft. (45.7 m) and 1,100 ft. (335 m) from the CMS display face under normal freeway operating conditions. Sign luminous intensity at testing shall be 12,400 candelas per square meter minimum (white) for full color displays. Verify the luminous intensity of the pixel will not decrease more than 50 percent when viewed at an angle of ±15 degrees when centered about the optical axis and perpendicular to the surface of the display.

4. Pixel Drive Circuitry

Electronic driver circuitry shall be provided for each LED pixel module and shall individually control all pixels on that module. The driver circuit boards shall meet the following requirements:

- Each LED driver board shall be microprocessor controlled and shall communicate with the sign controller on a wire or fiber optic communications network using an addressable network protocol. The microprocessor shall process commands from the sign controller to display data, perform diagnostics, and report pixel and diagnostic status.
- Constant current LED driver ICs shall be used to prevent LED forward current from exceeding the LED manufacturer’s recommended forward current whenever a forward voltage is applied. To maximize LED service

life, LED drive currents will not be allowed that exceed the manufacturer's recommendations for the 100.000 hour lifetime requirement.

- The LED pixels shall be directly driven using pulse width modulation (PWM) of the drive current to control the display intensity. This LED driver circuitry shall vary the current pulse width to achieve the proper display intensity levels for all ambient light conditions. The drive current pulse shall be modulated at a frequency high enough to provide flicker-free operation and a minimum of 200 brightness levels.
- The LED driver circuitry shall receive updated display data at a minimum rate of one (1) frame per second from the sign controller.
- Each LED driver circuit shall be powered by 24 VDC from external regulated DC power supplies. Each driver circuit shall receive power from a minimum of two (2) independent power supplies to provide redundancy. Indicator LEDs shall indicate the status of each power source.
- The voltage of each power input shall be measured to the nearest tenth of a volt and reported to the sign controller upon request. Each driver circuit shall also contain one status LED for each power source that indicates if the power source is present or not.
- The LED driver circuitry shall be able to detect that individual LED strings or pixels are stuck off and shall report the pixel status to the sign controller.
- The LED driver board shall contain an indicator showing the functional status of the LED pixel display module. At a minimum, it shall indicate error states of the LED pixels and communication network. The indicator shall be positioned so that a maintenance technician can easily view the status code for diagnostic purposes. The LED display module shall report the status, including pixel errors, voltage levels, etc. to the sign controller.

5. DC Power Supplies

Provide auto-ranging regulated DC power supplies for the LED pixel display modules that convert the incoming AC to DC at a nominal voltage of 24 volts DC. Power supplies shall be arranged in redundant pairs, wired in parallel configuration that uses multiple supplies for the CMS display matrix. The power supplies shall meet the following requirements:

- Power supplies shall be rated such that if one supply fails, the remaining supply shall be able to operate 100% of the pixels in that display region at 100% brightness .
- The power supply shall be sufficiently sized to maintain the appropriate LED display intensity throughout the entire operating input voltage range.
- The power supply output shall be connected to multiple circuits that provide power to the LED modules. Each output circuit shall not exceed 15 amperes and shall be fused.
- Power supplies shall be monitored by a microprocessor-controlled circuit. This circuit shall monitor the voltage of each power supply and the status of each output circuit's fuse. The power supply voltages and fuse state shall be reported via a controller communication area network to the sign controller upon request.
- The power supplies used to power the LED pixel modules must be identical and interchangeable throughout the CMS.
- The power supplies must be UL listed.
- The power supplies shall provide a nominal output voltage of 24VDC +/- 10% with a nominal maximum output power rating of 1000 watts, with an operating input voltage range of a minimum of 90 to 260 VAC.
- Each power supply shall automatically shut down and restart if the power supply overheats or an output fault occurs for over-voltage, over current or short circuit.

6. Ambient Light Measurement

Provide a changeable message sign with electronic light sensors. These devices shall permit automatic light intensity measurement of light conditions at each sign location. The sensors shall be mounted in a manner to measure front, rear and ambient light conditions.

The sensors shall be internally read by the CMS dimming system. The CMS sign controller shall continuously monitor the light sensors and adjust the LED display matrix intensity to a level that creates a legible message on the CMS face.

7. Environmental Control and Protection

a. The CMS shall be equipped with a minimum of one (1) ambient temperature sensor, one (1) internal temperature sensor and one (1) sensor that measures the relative humidity of the air inside the CMS housing. The external temperature sensor shall be placed and mounted such that it is never in direct sunlight. The internal temperature sensor shall be mounted in a well ventilated location inside the structure, easily accessible for maintenance and verification of accuracy. The relative humidity sensor shall be similarly mounted. All sensors shall report data to the CMS control software and be used to control systems for cabinet ventilation, sign face panel fog and frost prevention, and safe over-temperature shutdown.

b. Ventilation System: Provide the CMS housing with the necessary louvered vents positioned such that vehicle exhaust fume intrusion into the sign housing is minimized while the housing is provided with sufficient ventilation to maintain the thermostat temperature settings. Provide fans to positively pressure the CMS cabinet enclosure, thermostatically and parallel timer switch controlled, to keep the internal CMS air temperature lower than 140 °F (60 °C) when an outdoor ambient temperature is 115 °F (46 °C) or less..

   Provide an Over Temperature Safety Shutdown to automatically shut down the LED modules if the measured internal CMS air temperature exceeds a maximum threshold temperature. The threshold temperature shall be configurable and have a default setting of 140º F (60º C) .

   Each intake port shall be equipped with air filters that remove airborne particles measuring 500 microns in diameter and larger. Use replaceable dust filters across all vents and position them such that when in place a secure dust tight joint exists between the filter and the housing. Install fans in protected fan openings within the CMS housing such that moisture, dust, vehicle exhaust fumes, or insects or birds will not enter the fan opening. Walk-in signs shall have fans and air filters that are removable and replaceable from inside the CMS housing. A monitoring system shall be provided to report the fan(s) operation to the sign controller upon request.

   Provide an override timer switch for manual operation of the fans by maintenance personnel that, when placed in the on position will turn on the fans for a period of from zero (0) to four (4) hours.

   Provide an automatically controlled defog system that warms the CMS front face when the internal CMS relative humidity is near condensation levels. This system shall keep the front face polycarbonate panel free of fog and condensation.

8. Associated Cables and Wiring

Controller-to-Sign Interface cables shall be fiber-optic signal cable per manufacturer specifications or optionally, may be copper signal cable, CAT 5 cable with RJ45 connectors.

Protect all electrical cables against lightning or over-voltage conditions with appropriate surge protectors. Mount surge protection units in such a manner that component testing is not impaired and the replacement of components is easily accomplished without the removal of other components.

Ensure that grounding wire and connectors meet the requirements of the appropriate electrical codes and the applicable sections of GDOT Supplemental Specification 925.

D. CMS Controller

Each CMS shall be controlled and monitored by a CMS controller. This controller will be housed in a base mounted cabinet remotely located from the CMS structure so that diagnostics and maintenance may be performed at the cabinet while viewing the sign face.

1. General

The sign controller shall meet the following requirements:

- Shall communicate using embedded NTCIP protocol..
- NEMA TS 4 compliant
- Contains memory for storing custom and permanent messages, schedules and other files necessary for controller operation.
- Shall include a front panel user interface with graphical LCD and keypad for direct operation and diagnostics of the CMS.
- Provide a watchdog timer for detecting controller failure and resetting the microprocessor.
- Includes functions such as plan storage and communications with the CMS central control facility software which will be conducted by software resident in the controller unit.
- The unit shall be capable of providing electrical isolation, monitoring of sign status, detection of failed elements and other features particular to the sign design
- The CMS controller unit shall operate from a nominal 120 VAC, 60 Hz power supply. The power consumption of the CMS controller unit, power supply and permanently connected equipment cannot exceed 250 watts total.

Include with the CMS controller unit a power on/off switch that controls the AC power to the controller unit. Mount the switch on the front face of the enclosure and mechanically protect it from accidental shut off.

Provide a CMS controller unit and its associated software that meet all of the functional requirements of the CMS Specification and fully support the NTCIP protocol stack.

2. Communications

a. CMS Controller

Provide the CMS controller unit with a 100Base-TX or 10Base-TX Ethernet port to allow connections between the controller and the CMS central control facility or hub via the field communications system. This communication port shall be configured as MDI. This communication port shall use standard RJ-45 female connector.

Provide the CMS controller unit with a second communication port. This second port shall be an EIA 232-C serial communication port to allow connections between the controller and a laptop computer. This communication port shall be located on the front of the CMS controller enclosure and it shall be configured as DCE. This communication port shall use a 25-pin socket connector (ITT DB-25S or equivalent). The communication port shall support dial-up modems, spread spectrum radio modems, cellular phone data port connections, fiber optic modems, and other communication devices that are compliant with the RS-232 standard.

Provide the CMS controller unit with a fiber optic channel connection to allow connections between the controller and the changeable message sign. This communication port shall be compatible with the sign communication port.

Provide a communication timer within each CMS controller for detecting failure of communications with the CMS central control facility. The timeout value shall be selectable between one (1) and sixty (60) minutes with one-minute resolution. The timeout shall be capable of keypad and laptop commanded disabling for use during periods of dialup or similar communication service where a periodic poll of the CMS within the 1 to 60 minute period is not normally made. The default shall be the last selection made of either timeout or non-timeout.

3. Functionality

The functionality of the CMS is defined by the NTCIP protocol stack that has been defined for the CMS controller and the collection of data objects that exist in the MIB of the device. The following list constitutes an overview of the normal mode of operation of the CMS system. Normal mode of operation is defined as the state in which the controller is communicating with the CMS central control facility and processing requests from the central control facility. The major function of the controller is to change the message displayed at the CMS. Secondary functions of the controller may include the following: responding to status requests from the central control facility, storing new messages that have been sent to the controller from

the central control facility, sending configuration data to or receiving and updating configuration data from the central control facility, and sending the currently displayed message to the central control facility. During normal operation, the controller unit will expect at least one successfully communicated message during a specified time period from the central control facility; a configurable master communication timer controls this time period. If no message is received, the controller unit shall take over in its communication loss mode. Furthermore, upon receipt of a message, the CMS controller shall respond to the message within five (5) seconds. Should the controller fail to respond within this time period, the entity that generated the request will assume that the request has failed.

a. Data Objects for Controllers: The SNMP Application Level protocol shall be used to access all of the data objects that have been defined at the Information Level of the NTCIP protocol stack. The value of some data objects may be updated, and the value of all data objects may be retrieved. The control mode of the CMS controller shall affect the accessibility of these objects, and a discussion of the various control modes has been given below.

b. Dwell Time: Dwell time is the time required for displaying and blanking the sign (or part of the sign for two phase signs) and for flashing or blinking lines and symbols (or parts of lines). Dwell times shall be in units of tenths of a second and shall range from 0 to 5 seconds. Various MULTI tags and default values provide this functionality.

c. Maximum Response Time: The Maximum Response Time defines the maximum amount of time that the CMS controller can take to respond to a particular SNMP or STMP request. The Maximum Response Time for the CMS controller shall be five (5) seconds. Should the controller fail to respond within this time period, the entity that generated the request shall assume that the request has failed.

d. Master Communication Timer: The master communication timer keeps the time that has elapsed since the CMS local controller received a correctly formed SNMP or STMP request from the central control system, and it resets upon each request. The timer shall be in units of minutes, shall range from 1 to 60 minutes, and shall have a default value of 10 minutes.

e. CMS Default Messages: Store two default messages in non-volatile memory. The stored default messages shall be used when there is a communication loss between the controller and the central control facility or when the CMS controller unit reboots after a power failure. The default message selected will be a result of the failure type.

f. Blank Time: Blank time is the length of time the sign is blanked between changes in message display. Blank times shall be in units of tenths of a second and shall range from 0 to 10 seconds. Various MULTI tags and default values provide this functionality.

g. The CMS controller shall store two (2) default fonts for use in message display. The CMS controller shall be capable of storing four (4) graphic images and displaying one of these images at a time on the CMS.

   The CMS controller unit shall be capable of displaying the longest possible one-phase message within two (2) seconds of the receipt of the complete SNMP or STMP request.

   Messages shall be specified in the MULTI syntax. The presence of a tag in the message string shall override the default value that has been set if such a default has been configured. The following MULTI tags shall be supported:

   - Field
   - Flash
   - Font
   - Justification – Line
   - Justification – Page
   - Moving Text
   - New Line
   - New Page
   - Page Time

h. Controller States: A CMS can be in various states prior to the commands, which may affect how these functions are performed. These modes are:

Power Loss Mode: This mode is reached when power has been lost to the CMS controller, and it has switched to its backup power source. If this mode is reached, then the controller shall display the default message that pertains to power loss if this message has been set.

Communication Loss Mode: This mode is reached after a communication timeout has occurred which may be a result of the central control facility being offline or a disruption of the communication channel. If this mode is reached, then the controller shall display the default message that pertains to communications loss if this message has been set, and the master communication timer shall be disabled.

Local Mode: This mode is reached when the CMS controller unit has been put under manual control in the field. Any SNMP or STMP update requests received from the central control facility shall be ignored.

Central Mode: This mode represents the normal operation of the CMS controller. On a user selectable time basis, the central control facility software shall poll the controller unit for status to receive any failure or recovery information.

Central Override Mode: This mode can be used to override a CMS controller that has been placed in Local Mode.

i. Controller State Changes: The central control facility can change the operational state of the CMS controller. The Central control facility can send a local mode off command to the CMS controller unit.

The CMS controller shall be able to be put into Local Mode by field personnel at the CMS and shall be able to be controlled by the controller keypad or a laptop computer that has been attached to one of the serial interfaces. The message displayed on the sign shall not change when the CMS controller unit mode is changed to Local Mode. A CMS controller that has been switched into Local Mode shall ignore requests from the central control facility. The central control facility can override Local Mode by changing the operational state of the CMS controller to Central Override Mode.

j. Diagnostic Functions: Diagnostic functions shall allow the user to diagnose errors on a CMS controller unit. Ensure that the central control facility or a laptop computer is able to command the following:

Software Reset: Ensure that the reset request will cause the CMS controller unit to restart the control program . This is similar to a complete bootstrap of the CMS controller unit and shall be non-destructive of library messages stored in volatile memory. The following steps shall make up the reset process:

- Any temporary variables and the message displayed on the CMS shall be lost as the control program restarts and reinitializes such variables. The CRC of each message stored in the memory of the controller shall be recalculated and compared with the stored value. If the CRC comparison for a particular message fails, then the message shall be invalidated, and that storage slot shall be made available.
- If a default message has been defined for a reset, then it shall be displayed; otherwise, the sign shall be blanked.

Test Pattern: On command, the CMS controller shall display a test pattern on the CMS. The test patterns shall cycle through turning banks of display elements on and off. The pixels shall remain in each particular pattern for sufficient time for a user to validate the pattern. The requirement of this test pattern is to exercise each display element and allow the validation of the operation of all display elements. The preferred test pattern consists of a "checkerboard" of alternating modules that are on or off for a length of time and then reverse their polarity. Other test patterns of similar function, but not distractive to motorists, may be used subject to the approval of the Engineer.

Blank the CMS: On command, the CMS controller shall change all the display elements to the off position. The CMS display shall stay in this format until the next display command is received.

CMS Element Status: On command the CMS controller shall exercise the full diagnostics of the CMS including a report of any failed elements, condition bits set (e.g., power off, comm. failure, reset), etc.

Configuration Parameter Retrieval: On command, the CMS controller shall return the value of a particular parameter.

Message Retrieval: On command, the CMS controller shall return a particular message from its storage.

k. Regular Checks by the CMS Controller

Message Library: Each individual messages shall have a CRC stored with it when it is downloaded. The CMS controller unit shall recalculate the CRC of a particular message and compare it with the value stored whenever it attempts to display that message. Any difference shall cause a library error to be stored for reporting to the central control facility.

Failed Display Elements: The CMS controller unit shall verify all display elements on a regular basis. The CMS shall detect and report any display elements that are not controllable. Whenever a message is displayed, all elements that are to be enabled shall be checked immediately after the display is completed.

Major Component Checks: The CMS controller unit shall monitor the major components of the sign such as power supplies, pixels, the controller, light sensors, fans, or temperature sensors. If any of these components fail or become uncontrollable, the CMS controller unit shall record this for reporting to the central control facility. This monitoring shall be on each change of message displayed and at regular intervals.

Watchdog: The CMS controller unit shall keep a hardware watchdog on the sign's own operation. During normal processing, the processor shall reset this watchdog every few seconds. If this watchdog is not reset for a period, there shall be a hardware switch that will reset the CMS controller.

Controller Bootstrap: During the bootstrap process, the CMS controller unit (usually after a power failure) shall carry out the following steps:

- Any temporary variables, and the message displayed on the CMS, shall be reset as the control program starts and reinitializes such variables.
- The CMS controller unit shall recalculate the CRC of each message in its storage and compare it with the corresponding stored value.
- If a default message has been defined for a controller boot, then it shall be displayed; otherwise, the sign shall be blanked.

l. Controller Keypad: Provide a keypad on the controller face to input programming and CMS configuration data. The keypad shall allow full access to the CMS operating parameters and commands. A laptop computer or central computer system cannot be required to set up or operate the CMS.

m. Control of Sign Luminance

Illumination Control: The CMS controller shall provide multiple levels of illumination control.

- Light Sensor Control: The luminance level of the CMS shall be determined by the values of light sensors that are attached to the CMS.
- Manual Control: The luminance level of the CMS shall be determined by the value set by the central control agency

Luminance Levels: The luminance of a light emitting pixel shall have a minimum of three levels selected in accordance with the ambient illumination level as read by the light sensor system and the software control . Typical ranges are:

- overbright range, level 3
- daylight range, level 2
- night range, level 1

Equip the CMS controller unit with dimming circuitry that will allow selection of the light intensity levels for each range to best suit the sign location. The dimming scheme used cannot reduce the rated life of the light source. There can be no observable flicker or difference in consistency between pixels at any of the intensity ranges.

Incorporate sufficient hysteresis in the sensor or control circuit to ensure that no rapid or erratic changes are implemented when the environmental lighting level fluctuates around the threshold .

Sensor Failure: In case of sensor system failure, the light output of the sign display elements shall be defaulted to the night range setting.

E. CMS Controller Cabinet

The cabinet shall house all of the CMS equipment required to control, monitor, and communicate to the CMS and all of the equipment required to communicate with the communications hub or central facility as shown on the Plans. Include with the

equipment housed within the cabinet, as a minimum, the rack mounted CMS controller unit, the communication interface between the CMS and the CMS controller, the interface between the CMS controller and the fiber optic communication equipment and interconnection panel, the laptop computer interface, all power supplies and power termination and distribution equipment, all wiring, cables and jumpers, and all environmental protection material and equipment.

Provide the CMS controller cabinet with the necessary louvered vents positioned such that vehicle exhaust fume intrusion into the cabinet is minimized while the housing is provided with sufficient ventilation to maintain the thermostat temperature settings. Provide fans, thermostatically and parallel timer switch controlled, to pull warm air out of the cabinet to support the venting of the heat within the cabinet to the extent that an interior temperature of no more than 130 ºF (54 ºC) is reached with a 120 ºF (49 ºC) direct sunlight generated ambient temperature with the cabinet door closed and locked.

Use replaceable waterproof washable dust filters across all vents and position them such that when in place a secure dust tight joint exists between the filter and the cabinet. Install fans in protected fan openings within the cabinet such that moisture, dust, vehicle exhaust fumes, or insects or birds will not enter the fan opening.

Control the ventilation fan(s) by thermostat adjustable to operate the fan(s) between the range of 70 ºF to 130 ºF (20 ºC to 54 ºC). The on-off temperature delta of the thermostat shall be nominally 3 ºF (1.7 ºC). Verify that the current rating of the thermostat is no less than 200 percent of the respective controlled equipment. Install Quencharc or other suitable devices across the thermostat and switch contacts that will prevent electromagnetic interference being generated with the opening or closing of the thermostat contacts under electrical load.

Identify different components of the controller equipment including all the wires, connectors, control leads, switches, etc., with labels of engraved lamanoid or with permanent transfers. The identifiers shall correspond to the labels used in the equipment documentation and maintenance material.

Mount all protective devices such as lightning arrestors and surge protectors external to the CMS controller unit enclosure.

Provide FDC, Sliding Drawer, Field Switch, and Power panel.

All mounting hardware and wire connections shall be easily accessible and removable with hand tools.

Ensure that the driver circuitry installed in the controller cabinet meets or exceeds the electrical and environmental specifications of the CMS.

F. Interconnection Cables

1. Power Cables

Use bundled multi-conductor power cables connecting 120 volt circuits between the CMS controller unit and the CMS housing equipment power distribution area. Size the power cables as required by the load and distance.

2. Signal or Communications Cables

Use bundled, shielded, jacketed multi-conductor signal or communications cables to connect circuits of 50 volts or less (including fiber optic cable) between the CMS controller unit and the CMS housing. Size the cables as required by load and distance. If a parallel (non-multiplexed) means of interconnection is used between the controller unit and the sign, carry out tests approved by the Engineer to ensure that no significant signal deterioration occurs. Design the communication channels for acceptable noise margin limits specified by the logic family or drivers/receivers used.

Fiber optic cable may be used for the sign controller signal interface from either ground mounted or pole mounted cabinets.

3. Protective Devices

Provide all electrical cables entering the cabinet with surge protective devices installed inside the controller cabinet equal to or exceeding the requirements of GDOT Specification Section 925. The protective devices shall be encapsulated hybrid suppressers and shall be bayonet mounted such that replacement can be done without removal of the housing or other equipment.

631.3.05 Construction

A. General Requirements

Establish the electrical power service required for a CMS installation as described in Section 939.

B. Wiring, Cabling and Harnesses

Make all harnesses neat and firm, and route them to minimize crosstalk and electrical interference.

Separately bundle or shield wiring containing AC from all DC logic control circuits.

Route wiring to prevent conductors from being in contact with metal edges. Arrange wiring so that any removable assembly may be removed without disturbing conductors not associated with that assembly.

Install all wiring as a part of the CMS assembly and controller including power, communication, and fiber optic control cables between cables necessary to operate the changeable message signs. Install the cables in liquid tight conduit in inconspicuous locations, between the nipples on the sign support and the housing. Install the cables to use the sign support beams and legs as raceways and install them in continuous, un-spliced lengths between the housing and the CMS controller cabinet unit. Coil sufficient slack neatly in the base of the CMS controller cabinet to ensure that the connections to the housing and the power source will be possible without the need to add or splice any cables. At vertical transitions, support the cable by integral hooks or other methods that assure that the stress placed on the wiring or fiber optic cable is minimized and in no case violates the cable or wire manufacturers maximum static, pulling, or dynamic tension, or bend radius.

Route all wiring within the sign in properly supported cable trays.

C. CMS

1. General

The following section provides a description of a permanent changeable message sign (CMS) assembly. Ensure that the various subassemblies are interchangeable between the same type of sign and 100 percent compatible with NTCIP protocol stack.

2. Timing of Work

Ensure that CMS controller units are installed, tested, and ready for operation before installing the changeable message signs. Do not install changeable message signs until 14 calendar days or less, prior to beginning the proof of performance testing. Install the CMS during restricted times, as designated by the Department, and control all traffic using the GDOT approved pacing method. Proceed with installation only upon approval of the pre-installation tests results. Notify the Engineer 96 hours prior to installation.

3. Installation

Maintain full responsibility for the sign housing mounting to the support structure and confirm that the sign can be properly mounted on the sign support structure prior to installation. Provide complete structural shop drawings and calculations of the sign mounting to the support structure to the Department as part of the submittal data requirements in Section 631.1.03. Securely mount the sign on the sign support structure. Initially set the housing at a 3 degree tilt **forward** toward traffic and adjust the housing under both day and night conditions to optimize the view of the sign from the roadway by a motorist and eliminate random reflections as directed by the Engineer. Alternatively, the housing may be constructed at a 3 degree tilt toward traffic, if approved by the Engineer, but shall be adjusted to obtain the same optimization of the viewing of the sign from the roadway.

Signs mounted on roadside supports shall be angled toward the roadway by 7 degrees to maximize the viewing angle for motorists.

Attach and secure all mechanical hardware for initial attachment prior to the reopening of lanes to traffic. Complete attachment of hardware prior to the release of crane cables. Install and connect the CMS sign wiring and communications cables to the ground cabinet and disconnect switch in the controller cabinet only after attaching and securing the sign to the sign structure. During the proof of performance testing, the Engineer will evaluate the initial setting of the sign and direct the

Contractor to adjust the sign tilt if necessary. Use nylon stop washers with mounting attachments. For all structural aspects, stainless lock washers and nuts are unacceptable; use stainless steel nuts with nylon inserts for locking.

Lift and install the CMS housing and display in place on the overhead structure only with prior approval of, and in the presence of the Engineer. Do not lift and install the CMS housing and display until all equipment, materials, and labor are available such that the CMS can be operated with messages from the local CMS controller within 72 hours of installation on the overhead structure. Program message displays on the CMS at the direction of the Engineer. Make sight alignment adjustments to the CMS housing and display as directed by the Engineer.

Securely install mounting hardware to the torque recommended by the overhead sign support manufacturer.

4. Controller Unit to CMS Interconnection

Install all interconnecting cables between the equipment in the CMS controller cabinet and the sign inside two (2) 2" (50.8 mm) diameter ducts, which are installed between the sign footing and the concrete pad of the controller cabinet. If additional 2" (50.8 mm) ducts are required to accommodate the sign manufacturers interconnect requirements, add additional ducts in multiples of two (2) each, 2" (50.8 mm) ducts. Provide all communications between the ground mounted CMS controller cabinet and the above ground mounted sign in the form of fiber optic cable and signaling.

5. Cabinet Equipment

a. Wiring and Connections: Make all connections to terminal boards or screw-type equipment terminals with insulated fork-tongue compression connectors only when using stranded cable. Make all wiring to bulkhead connectors on equipment housings with MS bayonet-type connectors. Solder connector joints for use with extra-low voltage systems, with the joint metals preheated to the flow temperature of the solder or crimped using ratchet-type positive crimp tools and a double crimp (conductor and jacket) connector.

   Remove the outer jacket of data and communications cables to expose approximately 6 in. (150 mm) of the shielding or drain wire. Twist together and solder the shielding or drain wire for all cables serving a similar function with a #10 AWG minimum insulated (green) ground lead securely connected to the cabinet ground bus. Make the ground lead routing as short as possible. Cut the shield off and leave it isolated at the other end.

   Upon completion of wiring and connections, bundle all incoming cables and hold in place with nylon cable ties. Connect the front panel and chassis to the cabinet ground bus from a single point only.

   The controller will be powered from the power distribution assembly provided in the field cabinet. Bond the shields of all extra-low voltage cables to the ground bus inside the cabinet. The shield inside the sign enclosure shall be unconnected and insulated. Route low voltage cables and extra-low voltage cables installed in the cabinet on opposite sides of the cabinet. Group similar extra-low voltage cables in the controller cabinets, between common locations, together with cable ties. Install cables and connectors so that the manufacturer's rated minimum bending radius and pulling tension are not exceeded. Take proper care to prevent abrasions to the cable jacket during installation.

b. Controller Cabinet Installation: Install the CMS controller unit in the designated space of the field cabinet. Install the cabinet at locations as indicated on the Contract drawings or as designated by the Engineer. Mount all cabinet assemblies to the support pole at a height of 4 ft +/- 3 in (1.2 m +/- 76 mm) from ground level to the centerline of the cabinet housing. Where the Plans show base-mounted cabinets, install the cabinets in accordance with the Department’s Standard Specification for Traffic Signal Equipment installations.

6. Light Sensor System

Adjust the light sensor(s) and calibrate the dimming system consistent with field conditions found for each sign as a part of the installation process. Perform this work prior to any proof of performance acceptance test.

7. Support Material

Test the support material components specified in Subsection 631.4.A as per the appropriate pre-installation procedures as defined in the Specifications. Deliver the components prior to final acceptance of the Contract and beginning of the CMS support period.

631.3.06 Quality Acceptance

A. Use and Operations Prior To Final Acceptance

The Department will approve or control any and all CMS displays at all times that a display is in potential public view. When potential public view exists, no message or graphical display of any kind or activation of any CMS display component is permitted without prior approval of the Engineer. At such time as the Engineer determines that any given CMS is ready for Department control, the Department will exercise complete and total control of that CMS display and all central and local communications with that local CMS controller. Prior to any action, coordinate with the Engineer any remaining work or any testing or maintenance that may affect that CMS display. Do not interpret such CMS display control as acceptance of the project in whole or in part. Do not construe such action as a waiver by the Engineer of any provision of this Specification. Do not consider such use part of the burn-in period.

B. Utility Coordination

Establish the electrical power service required for a CMS installation as described in Section 939.

This Specification includes provisions whereby the Contractor furnishes or installs equipment and materials that will become part of the regional utility facility. Coordinate all such work with the utility representatives, and furnish all equipment and materials and perform all work in accordance with the Contract Documents and all applicable utility agency standards and procedures.

Meet all standards required by utility companies as related to CMS equipment, materials, and installation associated with attachment to related power service feeds or leased communication connections. Test the power and telephone utility service to confirm proper voltage and current capacity and the serviceability of any telephone circuit connected to CMS equipment.

Power utility or telephone utility representatives are not authorized to revoke, alter, or waive any requirements or design of materials or facilities provided under this Specification. The inspection of any of the Contractor's work by the utility providers or the failure to inspect any of the Contractor's work by the utility provider representatives will not relieve the Contractor of any requirements of this Specification.

Coordinate work with the utility providers to permit inspection of said work. Notify the Engineer and the utility providers' representatives of planned work.

C. Control of Work

Maintain all work under this Contract from the date of award of Contract to the date of final acceptance of the project by the Engineer. Maintain responsibility for making all trouble calls, diagnosis, repair, and replacement, supplying all equipment and materials; providing maintenance of traffic, and performing any other work necessary to maintain all work as required above. Within one (1) hour of notice from the Engineer or after other identification of a problem, make an on-site trouble call. Complete all work necessary to correct the problem within twenty-four (24) hours unless otherwise directed by the Engineer. Within 48 hours of having completed a trouble call or repair, provide a written report to the Engineer fully describing the problem, its cause, all action taken, and all equipment and materials repaired or replaced.

The Department will not be liable for any equipment or material purchased, work done, or delay incurred, prior to the Department's approval of said equipment or material through the materials submittal data process. Any failure of the Department to discover or note any unsatisfactory material will not relieve the Contractor of his responsibility for providing a complete operable CMS installation as called for under the terms of the Contract. Specifically describe any deviation from the Contract requirements and Specifications in the submittal documents along with a detailed description of the reason for the deviation.

D. CMS Environmental Operating Conditions

The equipment, materials, and systems will be installed in harsh environmental conditions and shall perform without failure to the performance levels defined within this specification. The normal AC power input, ambient air temperature, and ambient humidity are expected to be:

AC power input voltage 120 VAC, 60 Hz

Air temperature -20 °F (-28 °C) to 105 °F (40.0 °C)

Humidity 20 to 100 percent

It is further expected that under extreme conditions these values may deviate substantially from those normally experienced. As such, the equipment, materials, and systems shall perform to the level of performance or functionality defined within this specification without noticeable degradation under conditions outside of that normally experienced.

Conduct performance testing, in the presence of the Engineer, to demonstrate that the performance requirements and the CMS functionality are met. Ensure that all CMS assemblies and components are designed and tested to perform without degradation of performance or functionality within the environmental conditions defined within NEMA TS-4-2004 Section 2.1.5.. Demonstration of compliance is required under testing laboratory conditions to the extent of these NEMA standards.

E. Component Minimum Design Criteria

1. General

Ensure that all electrical, electronic, or electromagnetic components used in any CMS assembly have a minimum design life of not less than 10 years operating 24 hours per day under the environmental conditions defined under the acceptance test described within this specification. Use only components de-rated by 50 percent with regard to applied voltage and power dissipation unless otherwise specified so that material shortening of life or shift in values is minimized. All electrolytic capacitors used to filter circuits shall be de-rated by at least 150 percent of their normally operating voltage. All components shall be second sourced with the exception of specialty items for which the Contractor demonstrates that no commercially available second source component will meet the design or performance requirements of the CMS Specification.

2. CMS Pixels

Use only materials for the fabrication of the pixel display modules that will not be damaged by direct exposure to sunlight.

F. Acceptance Testing

1. General

This section describes Contract acceptance procedures for permanent CMS installations.

Unless otherwise noted in this Contract, develop, provide all equipment for, and perform all acceptance testing for all permanent changeable message sign installations. Develop detailed and thorough test procedures with full test plan descriptions, test and measurement equipment listings, and test results data sheets based upon the testing requirements defined within this specification. As part of the submittal requirements specified in Subsection 631.1.03, provide the following test plans for Engineer approval:

- Pre-Installation Test Plan
- Proof of Performance Test Plan
- Acceptance Test Plan

Use only test plans approved by the Engineer. Provide all necessary testing equipment, facilities, communications, transportation between test sites, and test documentation. Have a complete copy of all materials and equipment submissions and all documentary items on hand at all acceptance testing sessions.

At the conclusion of a test for a given CMS or for the CMS system, provide a thorough and detailed test report that documents the test process and the results of each portion of the testing. Provide a complete listing of test results. Deliver two (2) printed copies and one electronic copy on CD of this report to the Engineer within ten (10) calendar days after conclusion of that test.

Perform all testing in the presence of the Engineer and/or his representatives. Upon receipt of the Contractor's test report for a given CMS or system acceptance test, the Engineer will provide a written acceptance or rejection of that test within ten (10) calendar days.

If the results of a given test are rejected, the Contractor will be notified of the specific reasons for rejection. Make all necessary corrections and revisions to the subject materials and/or equipment and any accompanying documentary items. Upon completion of all necessary corrections and revisions, request a retest in writing. Include in the request for a retest a complete written summary of all corrections and revisions performed and, if applicable, revised documentary items. Do not commence with retesting without the Engineer's prior approval. Conduct all retests in accordance with all requirements of the

initial test. The successful completion of any phase of the testing will not relieve the Contractor of his obligation to fulfill any of the requirements of the Specifications.

2. Pre-Installation Testing

Perform pre-installation testing on each type and size changeable message sign in accordance with this specification. The pre-installation testing will be used to verify compliance and to ensure the operation, serviceability, and reliability of each sign prior to installation. Successful completion of the pre-installation testing is required prior to installation of any CMS assembly.

Develop a Pre-Installation Test Plan that includes all of the requirements of the NEMA TS-4-2004, latest version/addendum, and those additional requirements specifically defined within this specification.

During all pre-installation testing, test a complete CMS assembly for each sign type. A complete CMS assembly is defined as all elements included within the controller cabinet and the cabinet, and all elements included within the sign housing and the sign housing, as well as the interconnection cables and connectors. Configure and connect each CMS assembly as in the final field installation configuration. First perform the vibration and physical shock portions of the NEMA testing for each sign assembly. The vibration and physical shock (g-loads) portion of the tests need not be applied to the entire sign housing but representative assemblies of the display, display driver, power supply and distribution, and communication subassemblies mounted in the sign housing may be assembled as a representation of a complete CMS. Include at least one of each CMS assembly in the representative CMS subjected to the vibration and g-load shock test. Expose a complete CMS controller and controller cabinet assembly to the full NEMA tests described herein as well as the other tests parameters described within this specification. Expose a complete sign housing and display of each type and size to the temperature, humidity, and electrical shock tests defined within the NEMA tests.

Develop software and supply a laptop test computer for the pre-installation testing which communicates with the CMS using the NTCIP protocol stack. Demonstrate all commands to and all responses from the CMS, available in the protocol, using the test computer. Monitor all commands and responses through the use of a recording data analyzer.

Supply an environmental test chamber to perform environmental testing. The test chamber shall be capable of containing the CMS controller cabinet and an operational representation of the sign assembly that includes at least one of each type of operational assembly installed in the sign housing and provide a display capable of displaying at least one character in each sign row. The minimal display configuration shall be such that a test message containing text and graphics is viewable during the testing. During ambient temperature and humidity environmental testing, configure a complete CMS assembly. Provide an environmental chamber capable of achieving and sustaining, with the equipment and material placed in the chamber to be tested, temperatures of -30 °F (-34 °C), +70 °F (20 °C), and +130 °F (54 °C). During these temperatures, apply humidity levels to the maximum non condensing values obtainable, consistent with the temperature, to the equipment under test. Input power and signal lines shall have transient voltages applied as well as power interruption during the environmental testing sessions. Alternately, the entire sign, controller, and controller cabinet may be mounted in a modified refrigerated trailer that is capable of exposing the CMS assembly to the temperature and humidity extremes defined within the NEMA tests.

Commence with Pre-Installation Testing only after meeting all of the following requirements:

- All equipment and materials submissions associated with the CMS controller and housing have been approved by the Engineer.
- All documentary items as specified have been approved by the Engineer.
- The Engineer has approved the Pre-Installation Test Plan, testing schedule, and travel arrangements

Do not perform testing during any State or Federal holiday. Complete any given pre-installation testing session within five (5) consecutive GDOT working days unless otherwise approved by the Engineer. Successfully complete all pre-installation testing prior to installation of a CMS in the field.

3. Proof of Performance Testing

Perform Proof of Performance Testing on each permanent changeable message sign in accordance with the Specifications. The Proof of Performance Testing will be used to verify compliance with the Specifications and to ensure the proper installation and operation of each changeable message sign after all of the equipment and materials are placed in the field and all of the signs are made operational.

Perform the following functional testing using the test software and the laptop computer provided for testing:

- Demonstrate 100 percent compliance with the NTCIP protocol stack operating within an automated poll-response environment.
- Demonstrate every feature of the CMS controller and sign display assembly via direct connect and modem communications.
- Demonstrate fault-free operation of the CMS assembly under test when subject to 500 cycles of status request command and response operations between the CMS and the test software.
- Demonstrate fault-free operation of the CMS assembly under test when subjected to 1000 cycles of message download command, message download response, message display command, message display response, CMS status command, and CMS status response. Perform one complete cycle in 20 seconds or less with a CMS message constructed such that a character message fills every available character space on a two phase message. Set the phase time on to three seconds for each phase and the off time to zero seconds.

Record all communication between the test software and the CMS under test using an HP 4952A or equal protocol analyzer. Record serial data captured by the protocol analyzer on media printable from the protocol analyzer to an ANSII character printer. Provide the test results to the Department as part of the Proof of Performance test results.

Commence with Proof of Performance Testing at a given CMS location only after meeting all of the following requirements:

- All work required in the Plans and Specifications for that CMS location is completed.
- All Pre-Installation Testing for all CMS in the project has been successfully completed. All communications between the given CMS location and the central control facility has been established and tested as functional.
- The Proof of Performance Test Plan and testing schedule have been approved by the Engineer

Do not conduct testing during any State or Federal holiday. Complete any given Proof of Performance Testing session within five (5) consecutive GDOT working days unless otherwise approved by the Engineer.

4. Acceptance Testing

Perform Acceptance Testing on the entire CMS system in accordance with this specification. The Acceptance Testing will be used to verify that the entire CMS system was designed, constructed, installed, and operates as a complete system per the Plans and Specifications.

Perform the following operational performance testing using NaviGAtor software:

- Demonstrate 100 percent compliance with the NTCIP protocol stack operating within an automated poll-response environment.
- Demonstrate every feature of the CMS controller and sign display assembly via direct connect and modem communications.
- Demonstrate fault-free operation of the CMS assembly under test when subject to 500 cycles of status request command and response operations between the CMS and NaviGAtor software.
- Demonstrate fault-free operation of the CMS assembly under test when subjected to 1000 cycles of message download command, message download response, message display command, message display response, CMS status command, and CMS status response. Perform one complete cycle in 20 seconds or less with a CMS message constructed such that a character message fills every available character space on a two phase message. Set the phase time on to three seconds for each phase and the off time to zero seconds.

Record all communication between NaviGAtor software and the CMS under test using an HP 4952A or equal protocol analyzer. Record serial data captured by the protocol analyzer on media printable from the protocol analyzer to an ANSII character printer. Provide the test results to the Department as part of the Acceptance Test results.

Commence with Acceptance Testing only after meeting all of the following requirements:

- Complete all work required in the Plans and Specifications for the entire Contract, including the Contractor’s adjustment of the sign alignment on the sign support system, dimming system, test messages, communications, and test software.

- Successfully complete all Proof of Performance Testing for all CMS in the project.
- The Engineer has approved the Acceptance Test Plan and testing schedule.

Conduct no testing during any State or Federal holiday. Complete the Acceptance Testing session within five (5) consecutive GDOT working days unless otherwise approved by the Engineer.

G. Burn-In Period

1. General Requirements

Provide a 30-day burn-in period for all work and equipment included in the Contract. The burn-in period shall consist of the field operation of the changeable message sign system in a manner that is in full accordance with the changeable message sign system requirements of the Plans and Specifications. An acceptance test procedure is not required for the system burn-in.

Conduct only one (1) burn-in period on the entire Contract. Commence with the burn-in period only after meeting all of the following requirements:

- All work required in all Contract documents for CMS (may be combined with construction contract) (except this burn-in period) has been completed and inspected by the Engineer.
- Successfully complete all Acceptance Testing and corrective items.

Commence with the burn-in period upon written authorization by the Department to commence. Terminate the burn-in period 30 consecutive days thereafter unless an equipment malfunction occurs. Stop the burn-in period for the length of time any equipment is defective. After repairing the equipment so that it functions properly, resume the burn-in period at the point it was stopped.

Successful completion and acceptance of the burn-in period will be granted on the 30th day unless any equipment has malfunctioned during the 15th through 30th day of the burn-in period. If any equipment has failed during the 15th through 30th day, final acceptance will be withheld until all the equipment is functioning properly for 15 days after repair.

When a specific piece of equipment has malfunctioned more than three times during the 30 day burn-in period, replace that equipment with a new unit and repeat the 30 day burn-in period.

2. Contractor Responsibilities

During the burn-in period, maintain all work under this Contract in accordance with the Specifications. Restore any work or equipment to proper operating condition within 12 hours after notification.

3. Department Responsibilities

Department responsibilities during the burn-in period will be as follows:

- Expeditious notification of Contractor upon failure or malfunction of equipment
- In the event that the Contractor does not provide the services enumerated above under his Contract responsibilities, the Department or its authorized agents may in the interest of public safety take emergency action to provide for adequate traffic control. Pay any costs incurred as a result of these emergency actions. Such action by the Department will not void any guaranties or warranties or other obligations set forth in the Contract.

4. Burn-In Period Acceptance

The Department will make burn-in period acceptance after satisfactory completion of the required burn-in period and on the basis of a comprehensive field inspection of the complete CMS system in accordance with the Specifications. Upon burn-in period acceptance but prior to Final Acceptance of the entire Contract, maintain the complete CMS system in accordance with the requirements of Subsection 631.3.07.

H. CMS Controller

Provide a CMS controller unit with a design mean time between failures (MTBF) of a minimum of five years of continuous operation in the outdoor environment as calculated by a means approved by the Engineer.

631.3.07 Contractor Warranty and Maintenance

A. General

Provide a clearly stated Manufacturer support (usual and customary warranties) period for all equipment and materials furnished and installed as part of the pay item for CMS equipment and materials. Include in warranty and support, all contractor or manufacturer activities related to maintenance, removal and replacement of parts and materials during the period of support. Begin the Manufacturer support upon successful completion of the Proof of Performance Testing, as outlined in Subsection 631.3.06.F. All Manufacturer warranties shall be continuous throughout the period and state that they are subject to transfer to the Department. Manufacturer support during the warranty period for the Department shall include a technical support phone line, and the ability to provide immediate replacement parts/material for both warranty and non-warranty repair.

B. Support

Provide full technical support (for both parts and labor) for the period from the installation of all of the CMS in this contract until final acceptance of the contract for all Contractor supplied CMS components.

Provide support that covers maintenance and any defects in materials and workmanship for all system components. Make any replacements required during the support period without additional charge for labor, equipment and system components and other materials required. Support all system components notwithstanding any supplier's warranties whether written or implied.

During the support period, enter a precise description of repair work performed into the log book (supplied by the Department and located in the CMS controller cabinet and at the central control facility).

C. Response and Notification

Clearly identify in writing the designated contact person and alternate for liaison with the Department. The Department will designate representatives and alternates as contact persons for the control center and the field equipment and provide this information to the Contractor. Communicate with the Department’s designated representative, or alternate, prior to undertaking any maintenance or emergency repairs. Allow the Department's staff the option to accompany the Contractor's staff during the performance of component failure identification and corrective action, during maintenance activities, and during emergency repairs performance. Record all repair and maintenance activity log entries into field cabinet documents and at the control center in the log books provided by the Department.

Respond to emergency repair calls by the Department's coordinator of maintenance or the designated alternate. The Department's coordinator of maintenance or alternate will enter the time of the call and the time of arrival of the Contractor in an emergency repairs log book at the control center. This log book will be made available to the Contractor for his inspection upon request. Response time to reach the site of the malfunction shall be no more than three hours between 0900 hours and 1800 hours Monday to Friday, excluding State or Federal holidays; and six hours at any other time. Take no more than 24 hours from time of receiving notification to have the sign repaired to full functionality, meeting all requirements of the Specifications and confirmed by the Department representative, exclusive of requirements for the coordination of lane closure.

631.3.08 Training

A. General

Prepare and conduct training courses on the system for Department personnel and persons designated by the Engineer. A total of up to 20 GDOT designated personnel will attend the training sessions.

Conduct two types of training courses. The first type is for the engineering and operator personnel (one-day course). The second is for the maintenance personnel (one-day course).

Carry out training on dates mutually agreeable to the Engineer and to the Contractor. Notify the Engineer by giving 30 days notice of intent to carry out the training so that arrangements for attendance can be made. Develop the courses specifically for the system, assuming no prior knowledge of the communications, electronic or changeable message sign technology used. Provide a location to hold the courses that is an acceptable indoor and comfortable location near the project area. If requesting that the training be conducted away from the project area, pay all costs associated with travel and accommodation

of all the students. A member of the Contractors staff with intimate experience with this Contract shall attend the courses and provide answers to any inquires.

Provide a draft of the course material to the Engineer as specified in Subsection 631.1.03.O. Allow adequate time for reviews and revisions to ensure that the courses are held within the designated dates.

Training instructors shall be technically knowledgeable, competent, and proficient in the English language. Instructors shall have the following experience:

- Three (3) years in the design, maintenance, and implementation of CMS
- Taught at least one (1) training course within the last twelve (12) months

B. Training Content

Include an introductory level briefing to familiarize attendees with the CMS subsystem prior to the conduct of any acceptance testing of the CMS. A separate operator and engineering course shall include an overview of subsystem elements, the theory of operation of components, operating procedures and capabilities, and software applications. Involve "hands-on" use of all CMS equipment installed in the control center. Provide a separate technician level course to include relevant topics in electronics and communications interfaces. Provide a detailed description and explanation of the theory of operation of major CMS components; operation, test and installation procedures; troubleshooting, diagnostics and maintenance to the replaceable module level, including the use of test equipment and diagnostic tools, installation and alignment techniques during training. The technicians' level course shall also show how to use the system documentation to operate, diagnose, maintain, and expand the system. The technician level course shall also involve the "hands-on" use of the system, laptop computer and software, system test equipment, and any other Contractor supplied equipment.

631.4 Measurement

A. CMS

CMSs are measured for payment by the type and number actually installed, complete, functional and accepted. Unless otherwise specified in the Plans, include with a CMS installation, at a minimum, furnishing and installing the following:

- CMS controllers.
- All electrical, electronic, or electromagnetic components used in any CMS assembly, including but not limited to capacitors, potentiometers, resistors, semiconductor devices, transformers, inductors, circuit breakers, switches, terminal blocks, wiring, cabling, harnesses, indicators, light emitting modules, driver boards, sign control logic boards, opto-isolation cards, light sensors, sign electronics power supply, pin and socket connectors, PCB connectors, wire connectors, PCB assemblies, fans, and filters.
- All CMS housing components including, but not limited to, the housing assembly and mounting hardware, CMS platform and housing door, and maintenance safety eyebolts.
- Cabinet equipment, including but not limited wiring, conductors, terminal blocks, surge suppression
- Power cables to connect 120V circuits between the CMS controller unit and CMS housing equipment power distribution area.
- All weather heads, vertical conduit risers and conduit hardware on the CMS support pole for power service, grounding, and communications.
- All hardware and materials necessary to provide electrical power service to the CMS field location as shown in the Plans, including, but not limited to, vertical sections of conduit and conduit hardware. The Department will pay for horizontal runs of conduit separately as described in Section 682. The Department will pay for electrical power service assembly separately as described in Section 939.
- All cables, connectors, hardware, interfaces, supplies, and any other items necessary for the proper operation and function of any CMS system component with any other CMS system component.
- Development, installation, testing, and documentation of all software associated with the CMS controller unit.

Supply the following components as support material for all light emitting diode (LED) sign projects:

- LED Display modules 3 each, per sign
- LED drivers 3 each, per sign
- DC Power supplies 1 each, per sign
- Electronic Light Sensor assembly 1 each, per sign
- Sign control logic boards 1 each, per sign
- Fans 1 of each type, per sign

In addition for projects installing:

- One to nine CMS signs, provide one full CMS controller unit for ground cabinet and one CMS controller for sign housing
- Ten to fifteen CMS signs, provide two full CMS controller units for ground cabinet and two CMS controllers for sign housing
- More than fifteen CMS signs, provide three full CMS controller units for ground cabinet and three CMS controllers for sign housing

Include any miscellaneous labor, material, equipment, or services not specifically mentioned but required to make a complete and operational CMS installation within the CMS sign pay item as no separate payment will be made for same.

B. LED modules (Furnish Only)

LED modules units are measured for payment by the number actually furnished and accepted.

C. Power Supplies (Furnish Only)

Power supplies are measured for payment by the number actually furnished and accepted.

D. Sign Control Logic Board (Furnish Only)

Sign control logic boards are measured for payment by the number actually furnished and accepted.

E. Opto-Isolation Card (Furnish Only)

Opto-isolation cards are measured for payment by the number actually furnished and accepted.

F. Electronic Light Sensor (Furnish Only)

Light sensors are measured for payment by the number actually furnished and accepted.

G. Fan (Furnish Only)

Fans are measured for payment by the number actually furnished and accepted.

H. Filter (Furnish Only)

Filters are measured for payment by the number actually furnished and accepted.

I. CMS Controller (Furnish Only)

CMS controllers are measured for payment by the number actually furnished and accepted.

J. Testing

Testing is measured as a lump sum for full delivery of testing and acceptance requirements of all CMS included in the Contract.

K. Training

Training is measured as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training.

631.4.01 Limits

Not applicable

631.5 Payment

A. CMS

CMSs are paid for at the Contract Unit Price. Payment is full compensation for furnishing and installing the CMS.

CMS components are paid for at the Contract Unit Price. Payment is full compensation for furnishing each component.

Payment at 100 percent of the Contractor and vendor certified invoice price of materials to be permanently incorporated into the work will be allowed provided the Engineer determines that all requirements of the Specifications have been met. All partial payments shall be subject to the maximum Contract pay item increments defined for the particular Contract and subject to the Department's retainage requirements.

For all CMS materials and equipment, payment at 100 percent of the material or equipment invoice price up to a maximum of 75 percent of the Contract pay item bid price will be allowed on a per each basis provided the Engineer determines that the following requirements have been met per each:

- Successfully complete all Pre-installation testing.
- Deliver all CMS housing, display, wiring equipment and materials to the designated project area.
- Place the CMS in proper temporary storage.
- Submit a complete draft documentation package to the Engineer for review and approval for all of the CMS equipment, systems, controller and laptop software, and proof of performance testing.

For all communications materials and equipment, payment of 100 percent of the Contract pay item bid price will be allowed on a per unit basis provided the Engineer determines that the 30 days of the burn-in period have been successfully completed.

Payment for CMSs is made under:

Item No. 631	CMS	Per Each
Item No. 631	Pixel Unit	Per Each
Item No. 631	Light Emitting Module	Per Each
Item No. 631	Lamp	Per Each
Item No. 631	Driver Board	Per Each
Item No. 631	Sign Control Logic Board	Per Each
Item No. 631	Opto-Isolation Card	Per Each
Item No. 631	Light sensor	Per Each
Item No. 631	Sign Electronics Power Supply	Per Each
Item No. 631	Fan	Per Each
Item No. 631	Filter	Per Each
Item No. 631	CMS Controller	Per Each

B. Testing

The Department will pay for testing performed as prescribed by this Item, measured as provided under Measurement at the Lump Sum Contract Bid Price.

Payment for testing is made under:

Item No. 631	Testing	Lump Sum

C. Training

The Department will pay twenty-five (25%) of the total contract bid amount for training upon approval of the Training Plan. The Department will pay the remaining seventy-five (75%) after completion of all training as described in Subsections 631.3.08. The total sum of all payments cannot exceed the original contract amount for this item.

Payment is made under:

Item No. 631	Training	Lump Sum

631.5.01 Adjustments

Not applicable

Date: 27 May 2005

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

Section 642 — Cable Barrier

Add the following:

642.1 General Description

This work includes furnishing and erecting cable barrier and appurtenances according to the Specifications. Conform to the lines, grades, and locations shown on the Plans or as directed.

Place cable barrier as shown on the Plans and in the Proposal.

Unless provided for on the plans, this work includes:

- Grading to construct 6H:1V or flatter slope approaches for cable barrier as well as concrete line post foundations according to Section 205, Section 208, and Section 209.
- Furnishing and setting line post foundations for cable barrier according to Section 500.
- Furnishing and setting line posts, wire rope, and all necessary hardware for cable barrier and end terminals as specified by the Plans, Details, or the manufacturer's specifications and as approved by the Engineer.
- Conduct installation training prior to the installation of the system and maintenance training after installation of the system.

642.1.01 Definitions

General Provisions 101 through 150.

642.1.02 Related References

A. Standard Specifications

Section 205 – Roadway Excavation

Section 208 – Embankments

Section 209 – Subgrade Construction

Section 500 – Concrete Structures

Section 645 – Repair of Galvanized Coatings

Section 700 - Grassing

B. Referenced Documents

General Provisions 101 through 150.

National Cooperative Highway Research Project Report 350 (NCHRP 350)

642.1.03 Submittals

General Provisions 101 through 150.

642.2 Materials

A. Cable Barrier System

1. Install an interwoven prestretched four-rope cable barrier system meeting NCHRP 350 TL 4. Provide all system materials and components, including but not limited to, wire rope, fittings, posts, and terminals, according to the manufacturers specifications and details. Provide the FHWA letter of approval for NCHRP 350 TL-4 compliance.

B. Concrete

Concrete for line post foundations and end terminals shall be Class "A" concrete meeting the requirements of Section 500.

C. Training Materials

Provide twenty (20) installation manuals and other materials deemed necessary to conduct training for proper installation and maintenance of the cable barrier system.

642.3 Construction Requirements

642.3.01 Personnel

General Provisions 101 through 150.

642.3.02 Equipment

General Provisions 101 through 150.

642.3.03 Preparation

General Provisions 101 through 150.

642.3.04 Fabrication

A. Line Posts, Wire Rope, Fittings

Fabricate and install line posts, wire rope, fittings and other appurtenances according to the Plans, Details, the manufacturer's specifications, or as approved by the Engineer.

642.3.05 Construction

A. Erection of Line Posts

1. Grade the slope approaching the cable barrier to 6H:1V or flatter, according to Section 205 and Section 208.
2. Excavate for paving strip under cable barrier and for line post foundations as shown on the Plans or the manufacturer's specifications and according to the requirements of Section 205.
3. Prepare the subgrade surface according to the requirements of Section 209.
4. Pour line post foundations, setting line post sleeves for each line post foundation at the positions, depth, spacing, and alignment shown on the plans or the manufacturer's specifications and according to the requirements of Section 500.
5. After curing of the line post foundations, set line posts in the line post sleeves, paying close attention to the horizontal and vertical alignment of the posts. Posts must be set to achieve the

proper wire rope height. Posts and foundations not set at the proper line and grade shall be replaced prior to installation of the wire rope.

B. Erection of End Terminals

1. Install end terminals according to the Plans, Details, the manufacturer's specifications, or as approved by the Engineer.
2. Use end terminals meeting the requirements of NCHRP 350 TL-4. Obtain copies of the manufacturer's details and installation instructions and provide copies of the same to the Engineer prior to installation of the unit. Provide the FHWA letter of approval for NCHRP 350 TL-4 compliance of the assembly to be used.

C. Install and Tension Wire Rope

1. Install wire rope at the proper height according to the Plans, Details, the manufacturer's specifications or as approved by the Engineer.
2. Tension wire rope immediately after initial installation.
    a. Recheck and adjust tension three to five days after initial tensioning on segment lengths over 2,500 linear feet (762 m).
    b. Maintain a tension log showing time, date, location, ambient temperature, and final tension reading, signed by the person performing the tension reading. Give the log to the Engineer after tensioning is completed, along with the manufacturer's recommended tensioning chart.

D. Damaged Spelter Coating

Repair damaged spelter coating according to the requirements of Section 645.

E. Installation Training and Certification

1. Provide installation training and certification by the manufacturer of the system prior to installation of the system.

    a. Provide a minimum of eight (8) hours of classroom instruction on the installation of the system. This training shall be provided in a location central to the project and the local GDOT District Office. The scheduling and location of this training shall be approved by the Engineer.

    b. Provide on site field instruction by the manufacturer of the system using a minimum 2000 foot section of the system. The amount of this training will be as necessary to provide field training on all aspects of the system installation, including grading, line post installation, wire rope installation and tensioning, and terminal or anchor installation.

    c. Provide certification by the manufacturer of the system for the participants of the training. This certification shall require participants to pass a written examination given manufacturer of the system. The installation contractor must have certified personnel on site at all times during the installation of the system.

    d. Provide the training and certification as required by Section 642.3.05.E.1.a,b,c for a maximum of twenty (20) participants, to include the following:

        - Contractor (Prime)
        - Installation Contractor (Sub)
        - GDOT Personnel (Construction, Maintenance, and Traffic Safety and Design)
        - FHWA representative when system installed on Federal Aid Projects

2. Provide maintenance training by the manufacturer of the system after installation of the system.

    a. Provide a minimum of four (4) hours of classroom instruction on the maintenance and repair of the system. This training shall be provided in a location central to the project and the local GDOT District Office. The scheduling and location of this training shall be approved by the Engineer.
    b. Provide a minimum of four (4) hours of on site field instruction on the maintenance and repair of the system.
    c. Provide the training as required by Section 642.3.05.E.2.a,b for a maximum of ten (10) participants, to include the following:

        - GDOT Personnel (Construction, Maintenance, and Traffic Safety and Design)
        - FHWA representative when system installed on Federal Aid Projects

642.3.06 Quality Acceptance

General Provisions 101 through 150.

642.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

642.4 Measurement

A. Cable Barrier

Cable barrier is measured in linear feet (meters). Measurement does not include anchors or terminals.

B. End Terminals

This item is measured by the actual number of each type installed according to the specifications or details shown on the Plans.

642.4.01 Limits

General Provisions 101 through 150.

642.5 Payment

Cable barrier, complete in place including posts, foundations, and hardware will be paid for at the Contract Price per linear foot (meter).

End terminals will be paid for at the Contract Price per each assembly, complete in place.

For projects that do not include grading as a Pay Item, payment for cable barrier, anchors, and terminals includes:

- Embankment material for shoulders or excavation of material as shown on the Standard Details or Plans
- Compacting embankment material for shoulders or excavated areas according to Section 208
- Removing vegetation and obstructions before placing the embankment or excavating the material
- Grassing the disturbed area in accordance with Section 700

Payment will be made under:

Item No. 642	Cable Barrier	Per linear foot (meter)
Item No. 642	Cable Terminal (NCHRP 350 TL-3 compliant)	Per each
Item No. 642	Cable Terminal (NCHRP 350 TL-4 compliant)	Per each

642.5.01 Adjustments

General Provisions 101 through 150.

August 15, 2013

Revised February 10, 2014

DEPARTMENT OF TRANSPORTATION

STATE OF GEORGIA

SPECIAL PROVISION

PROJECT NO:

PI NO:

Section 670—Water Distribution System

Delete Section 670 and substitute the following:

670.1 General Description

This work consists of furnishing materials, labor, tools, equipment, and other items necessary for installing, removing, abandoning, relocating, and adjusting water distribution systems according to the Plans and Specifications.

670.1.01 Definitions

A. General Provisions 101 through 150

B. Whenever the terms "City", "County," or [Fulton County] are used in this Special Provision and its related documents, it shall be understood to mean [Fulton County] its subsidiaries, successors and/or assigns, hereafter referred to as Utility Owner.

C. The term "Project Manager" shall mean the authorized individual having the authority to give instructions pertaining to the work and to approve or reject the work. The "Project Manager" shall not however be authorized to revoke, alter, enlarge, relax, or release any requirements of the Contract, Plans, and Specifications, nor shall they act as an agent for the Contractor. All Contract items pertaining to the Utility Owner shall be coordinated with the Georgia Department of Transportation's (GDOT) Project Manager and the Utility Owner.

670.1.02 Related References

A. Standard Specifications

Section 104—Scope of Work

Section 107—Legal Regulations and Responsibility to the Public

Section 108—Prosecution and Progress

Section 205—Roadway Excavation

Section 207—Excavation and Backfill for Minor Structures

Section 210—Grading Complete

Section 400—Hot Mix Asphaltic Concrete Construction

Section 444—Sawed Joints in Existing Pavements

Section 500—Concrete Structures

Section 600—Controlled Low Strength Flowable Fill

Section 611—Relaying, Reconstructing or Adjusting to Grade of Miscellaneous Roadway Structures

Section 615—Jacking or Boring Pipe

Section 810—Roadway Materials

B. Related Documents

1. General Provisions 101 through 150.
2. All products supplied and all work performed shall be in accordance with [Fulton County Technical Specification for Water Main Construction], applicable standards from American Society for Testing and Material (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), GDOT Utility Accommodation Policy and Standards, and the Georgia Environmental Protection Division (EPD) Minimum Standards for Public Water Systems. Latest revisions of all standards shall apply.

670.1.03 Submittals

A. General Provisions 101 through 150.

B. Refer to the [Fulton County Technical Specification for Water Main Construction], current published edition, for water utility submittal requirements. Copies of all submittals and documentation shall be submitted to GDOT, who shall distribute to the Utility Owner.

C. Shop Drawings / Product Data

1. Submit [4] copies of the following submittals to the GDOT Project Manager:
    a. Product data, including size, dimension, capacity, pressure rating, accessories, and special features, installation instructions, and operating characteristics for all proposed materials to show compliance with the requirements of this Special Provision.
    b. Test reports specified in the Quality Acceptance section of this Special Provision.
    c. Pipe manufacturer certification of compliance with specifications.
    d. Operation and maintenance literature, warranties, and other specified information.

D. Construction Record Documentation

1. The Contractor shall record on two sets of utility as-built drawings that will record changes and deviations from the Contract Drawings in sizes, lines or grade. Record also the exact final horizontal and vertical locations of underground utilities and appurtenances to an accuracy of +/- 0.2 ft, referenced to permanent surface improvements. Drawings shall utilize State Plane Coordinates and shall be legibly marked to record actual construction and submitted to GDOT no later than 30 days after installation and prior to Final Acceptance of the Project. The Utility Owner shall determine if the utility record drawings are complete prior to Final Acceptance of the project.
2. Record Drawings shall be signed and sealed by a professional engineer or land surveyor registered in the State of Georgia.
3. Record Drawings shall also be submitted in digital format as indicated in accordance with the Department's current Electronic Utility File Guidelines.
4. Except for standard bound materials, bind all 8.5"x11" (A4) documentation, including 11" x 17" (A3) drawings folded to 8.5"x11" (A4), in logical groupings in loose-leaf binders of either the 3-ring or plastic slide-ring type. Permanently and appropriately label each such bound grouping of documentation.

670.1.04 Quality Assurance

A. The Contractor shall comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state or federal authorities having jurisdiction over the Project.

B. Furnish manufactured items, pipe, fittings, valves, service components, and appurtenances from manufacturers having regularly produced such items as specified herein which have proven satisfactory in actual service, over at least a 2-year period, or as approved by the Utility Owner and GDOT.

C. Regardless of tolerances permitted by industry standards specified herein, the Utility Owner or the GDOT Project Manager may reject pipe or appurtenances at the manufacturing plant or project site which have cracks, chips, blisters, rough interior or exterior surface, evidence of structural weakness, joint defects, or other imperfections that might in the opinion of the Project Manager contribute to reduced functional capability, accelerated deterioration or reduced structural strength.

D. The Utility Owner and the Utility Owner's consultant shall have the right to visit and inspect the work at any time. The Utility Owner may also have an Inspector assigned to the project authorized to inspect portions or all of the utility work done and the preparation, fabrication, or manufacture of the materials to be used. The Utility Owner shall be able to advise GDOT Project Manager of any observed discrepancies or potential problems. The cost of these inspections shall be the responsibility of the Utility Owner.

E. GDOT shall notify the Utility Owner before authorizing any changes or deviations which might affect the Utility Owner's facilities. Contractor shall notify GDOT and Utility Owner a minimum of 24 hours prior to beginning work on utilities.

F. The Utility Owner shall be notified by GDOT Project Manager when all utility work is complete and ready for final inspection. The Utility Owner shall be invited to attend the final inspection and may provide a corrections list to GDOT Project Manager prior to the final inspection.

G. The Contractor shall verify the actual location and depth of all utilities prior to construction. All utilities and structures shall be protected during construction. Any damaged facilities shall be repaired or replaced at the Contractor's expense.

670.2 Materials

All materials provided shall be in conformance with the requirements and standards set forth in the [Fulton County Technical Specification for Water Main Construction], current published edition. All pipeline and appurtenance materials in contact with potable water shall be National Sanitation Foundation (NSF) 61 Certified and part of GDOT QPL list.

Pipes and appurtenances shall comply with Section 1417(a)(1) of the Safe Water Drinking Act as amended in 2011 which prohibits the use of any pipe, any pipe or plumbing fitting or fixture, and solder, or any flux, after June 1986, in the installation or repair of (i) any public water system; or (ii) any plumbing in a residential or non-residential facility providing water for human consumption, that is not lead free as defined in Section 1417(d).

670.2.01 Water Piping systems and Appurtenances

A. Ductile Iron Pipe and Fittings

1. Ductile iron pipe shall meet the latest edition of ANSI/AWWA C150/A21.50 and C151/A21.51 for the class and joint specified with a nominal laying length of 18 (5.5 m) to 20 feet (6 m). Joints for buried ductile iron pipe shall be mechanical or push-on joints. Unless specified otherwise in [Fulton County Technical Specification for Water Main Construction], ductile iron pipe diameters 12 inch (300 mm) or less shall be minimum Pressure Class 350, while pipe diameters greater than 12 inch (300 mm) shall be minimum Pressure Class 250.
2. Ductile iron pipe for the interior of structures and above ground installations shall be flanged. Flanges shall be ductile iron and shall be threaded-on flanges conforming to ANSI/AWWA C115/A21.15 or cast-on flanges conforming to ANSI/AWWA C110/A21.10. The minimum class thickness for ductile iron flanged pipe to be threaded is Class 53.
3. Interior surfaces of ductile iron pipe and fittings shall be cement mortar lined in accordance with AWWA C104.

4. Ductile iron shall have an exterior coating as specified in AWWA C151 for ductile iron pipe and AWWA C153/C110 for ductile iron fittings.
5. Buried ductile iron pipe and fittings shall be polyethylene encased at locations indicated on the Plans or as conditions warrant. Polyethylene encasement tubing shall be in accordance with ANSI/AWWA C105/A21.5 and ASTM A674 and shall have a minimum thickness of 8 mils. Polyethylene encasement tubing shall be blue in color to designate potable water.
6. Fittings: Ductile iron fittings shall be epoxy coated and meet the requirements of ANSI/AWWA C153/A21.53 or ANSI/AWWA C110 A21.10 with a minimum pressure rating of 250 psi. Ends shall be restrained mechanical joint. All ductile iron fittings shall bear the NSF approval seal for potable water pipe.
7. Mechanical Joint Fittings: Mechanical joints consisting of bell, socket, gland, gasket, bolts, and nuts shall conform to ANSI/AWWA C111/A21.11.
8. Push-On Joints: Push-on joints shall be designed in accordance with ANSI/AWWA C111/A21.11. Joint lubrication shall be as furnished by the manufacturer.
9. Rubber gasket joints for push-on or mechanical joints shall conform to the requirements of ANSI/AWWA C111/A21.11.
10. Restrained Joints: Restrained joints shall be provided as shown on the Plans and where required for thrust restraint. Restrained joints shall not require field welding or grooves cut into the pipe barrel for restraint. The restraining joints for mechanical joint fittings shall conform to the requirements of ANSI/AWWA C111/A21.11 with assembly in conformance with AWWA C600 and manufacturer's recommendations. Restrained joints for pipe shall be mechanical joints with ductile iron retainer or push-on type joints and shall have a minimum rated working pressure of 250 psi.
11. Mechanical joint retainer glands may be used to restrain mechanical joint pipe and fittings to the plain end of ductile iron pipe and fittings. Restrainer glands shall be manufactured of ductile iron per ASTM A536.
12. Corrosion-resistant bolts used with ductile iron joints shall be high-strength, low-alloy steel as specified in ANSI/AWWA C111/A21.11.
13. Welded Outlets: Welded outlets in ductile iron pipe shall be provided where specified and indicated on the Plans. Outlets shall be fabricated by welding sections of ductile iron pipe manufactured in accordance with ANSI/AWWA C151/A21.51. Welded outlet pipe shall be fabricated only by the pipe manufacturer. The minimum ductile iron pipe thickness for fabrication of welded outlet pipe shall be Thickness Class 53 for 4-inch to 54-inch (100 to 1350 mm) diameter pipe. All joints on welded-on branch outlets shall be provided in accordance with the latest revision of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA C115/A21.15, as applicable. After the outlets are welded together and prior to finishing, the assembly shall be subjected to a 15 psi air test for leakage. The maximum size and laying length of the welded-on branch outlet shall be recommended by the pipe manufacturer and acceptable to the Utility Owner for the field conditions and connecting pipe or valve.

B. Polyvinyl Chloride (PVC) Pipe

1. PVC pipe diameters 4-inch through 12-inch (100 mm to 300 mm) shall meet ANSI/AWWA C900 requirements, and shall be a minimum pipe dimension ratio (DR) 18, Pressure Class 235 psi. PVC pipe diameters 14-inch (350 mm) and greater shall meet ANSI/AWWA C905 requirements, shall be DR 18 minimum, Pressure Class 235 psi. Pipe shall have a bell with an integral wall section with a factory installed, solid cross section elastomeric ring in accordance with ASTM F477.
2. All PVC pipe shall be formulated for sunlight exposure, be blue in color to designate potable water, and bear the NSF approval seal.
3. Joints for 4-inch (100 mm) and larger PVC pipe shall meet the requirements of AWWA C900/C905, latest edition. The rubber gaskets used for the joints shall consist of flexible elastomeric material conforming to ASTM F477.

4. PVC pipe shall have the same outside diameter (OD) as ductile iron pipe and be compatible for use with ductile iron fittings.
5. Fittings for PVC pipe 4 inches (100 mm) and larger shall be ductile iron mechanical joint and comply with the requirements set forth in the specifications for Ductile Iron Pipe and Fittings.
6. Restrained Joints: Restrained joints shall be provided as shown on the Plans and where required for thrust restraint. Restrained joints shall comply with the requirements set forth in the specifications for Ductile Iron Pipe and Fittings.
7. Unless specified otherwise in the Plans or [Fulton County Technical Specification for Water Main Construction], 2-inch (50 mm) and 3-inch (75 mm) diameter PVC pipe shall conform to the requirements of ASTM D2241 Class 1120 or 1220 (SDR 21) with a working pressure rating of 200 psi with integral bell gasketed joints. Pipe is to be manufactured to IPS standard pipe equivalent outside diameters.
8. Schedule 80 PVC pipes smaller than 4-inch (100 mm) nominal diameter shall be in accordance with ASTM D1785. Schedule 80 pipe shall have threaded joints. Solvent cemented joints are not allowed for buried pipes. Threaded type fittings for Schedule 80 PVC pipe shall be in conformance with ASTM D2464. All threaded joints shall be watertight.
9. Flanges for Schedule 80 PVC pipe shall be rated for a 150 psi working pressure with ANSI B16.1 dimensions and bolting pattern. Flanges shall be connected to PVC piping with threaded joints in accordance with ASTM D2467 or ASTM 2464, respectively.

C. Fusible PVC Pipe

1. Fusible PVC pipe sizes 4-inch (100 mm) to 36-inch (900 mm) shall conform to AWWA C900/C905 as applicable and follow the dimension ratios (DR) set forth in the requirements listed for PVC pipe.
2. Fusible PVC pipe shall be blue in color to designate potable water.
3. Fusible PVC pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.
4. Fusible PVC pipe shall be manufactured in a standard 40-foot nominal length-, or custom lengths as specified.
5. Joints shall be made by butt fusing sections of pipe with manufacturer-approved equipment.
6. Fittings shall be ductile iron mechanical joint and comply with the requirements set forth in the specifications for Ductile Iron Pipe and Fittings.

D. High Density Polyethylene (HDPE) Pipe

1. HDPE pipe sizes 4-inch (100 mm) and larger shall be a PE 4710/3408 high density, extra-high molecular weight polyethylene manufactured from first-quality high density polyethylene resin containing no additives, fillers, or extenders. The HDPE pipe shall have an ASTM D3350 cell classification of PE 445574C , shall meet the requirements of AWWA C906, and shall be sized based upon the ductile iron pipe size (DIPS), outside diameter (OD) sizing system.. The HDPE pipe shall be a minimum DR 11, pressure class 160 psi, and shall bear the NSF approval seal.
2. HDPE pipe shall be blue or marked with a permanent blue stripe to designate potable water.
3. Joints shall be made by butt fusing sections of pipe with manufacturer-approved equipment.
4. Fittings shall be ductile iron mechanical joint meeting the requirements of ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11.
5. The pipe shall have fusion welded restrainer ring, follower gland, and a 12-inch (300 mm) stainless steel insert for the mechanical joint connection.
6. HDPE water mains shall be properly sized utilizing the inside diameter of the nominal pipe diameter. If during construction HDPE is substituted for other pipe materials, the Contractor shall verify that the inside diameter of the HDPE is the same or larger than the inside diameter of the pipe originally specified.

E. Steel Casing Pipe

1. All materials, design, fabrication, handling, and testing of steel casing pipe shall conform to the requirements of ASTM A139, AWWA C200 and AWWA Manual M11 "Steel Pipe – A Guide for Design and Installation."
2. Steel casing pipe shall be new, smooth-wall, carbon steel pipe conforming to ASTM Specification A139, Grade B with a minimum yield strength of 35,000 psi. Steel casings shall be used with the size, minimum thickness, length, and coating specified on the Plans or [Fulton County Technical Specification for Water Main Construction].
3. Additional anti-corrosion measures, as specified by the manufacturer or indicated on the Plans, shall be provided at connectors, couplings, rollers, restraints, etc.
4. Unless specified otherwise in the Plans or [Fulton County Technical Specification for Water Main Construction], casing pipe end seals shall consist of ⅛-inch (6 mm) thick flexible synthetic rubber boot with adjustable stainless steel banding straps. The annular space of the casing shall not be filled with concrete or grout.
5. Casing spacers shall consist of a stainless steel shell, PVC ribbed liner, and non-conducting separators to keep the carrier pipe from touching the casing pipe. Spacers shall be provided at a maximum of 10-foot intervals and within 2 feet (0.6 m) of the end of the casing pipe.

F. Pipe Detection Wire

1. Unless otherwise specified by the Plans or [Fulton County Technical Specification for Water Main Construction], open cut installations of non-metallic pipe shall include minimum #12 gauge tracing wire. Pipe installed by directional drill shall include two (2) insulated 8 gauge tracer wire. Wire shall be solid copper insulated with HDPE installed along pipe, wrapped around service line stub outs and stubbed into valve boxes for locating purposes. Wire shall be properly spliced to provide continuous conductivity.

G. Warning Tape

1. Water mains shall be installed with polyethylene film warning tape manufactured for marking and identifying underground water utilities. Tape shall be a minimum of 2 inches (50 mm) wide and 4 mils thick, blue in color, with continuously printed letters reading “CAUTION BURIED WATER LINE BELOW”.

H. Gate Valves

1. Gate valves 3 inches (80 mm) and larger shall be of the resilient seat type meeting the requirements of AWWA C509 or C515. Valves shall be iron body, bronze trimmed, with non-rising stems, and shall be fusion-bonded epoxy coated per ANSI/AWWA C550. Valves shall have a minimum design working pressure of 200 psi.
2. Valves shall be manually operated by nut and open counter-clockwise unless specified otherwise in the Plans or [Fulton County Technical Specification for Water Main Construction].
3. The resilient seating arrangement shall provide zero leakage at the design working pressure when installed with line flow in either direction. All ferrous surfaces inside and outside shall have a fusion bonded epoxy coating. All valves shall be provided with O-ring seals. The design and machining of valves shall be such as to permit replacing the O-ring seals in the valves while in service without leakage.
4. All gate valves, when fully opened, shall have an unobstructed waterway diameter equal to or larger than the full nominal diameter of the valve.
5. In general, valves shall be designed for vertical installation. Valves installed in the horizontal position shall be provided with bevel gears, extended gear case, rollers, tracks, and scrapers.
6. Exposed or above-ground gate valves shall be outside screw and yoke (OS&Y) flanged joint type with an operating hand wheel. The face-to-face dimensions and drilling shall conform to ANSI B16.10 for Class 125 flanged joint end gate valves.
7. Valves shall include mechanical joints, bolts, glands, gaskets, and all other materials necessary to join to existing work.

8. Provide brass identification tag imprinted with “WATER”, valve size, valve type, and direction and number of turns to open. Provide a ¼-inch (8 mm) hole in the brass tag and attach the tag to the end of the locate wire (twist wire around tag). Tag shall be 2-inch (50 mm) diameter and ⅛-inch (6 mm) thick brass with a ¼-inch (8 mm) hole.

I. Insertion Valve

1. Insertion type valves shall be resilient wedge gate valves designed to be installed into an existing pressurized potable water main without interruption of flow through the pipe and no reduction of line pressure.
   a. Valve shall be fusion-bonded epoxy coated in compliance with AWWA C550.
   b. The construction of the resilient wedge shall comply with AWWA C509 requirements.
   c. The resilient wedge shall be fully encapsulated with EPDM rubber and shall seat on the valve body and not the pipe. The resilient wedge shall be totally independent of the carrier pipe.
   d. Valve shall be restrained to the pipe.
   e. Valves shall be suitable for operating pressures up to 250 psi.

J. Butterfly Valves

1. Butterfly valves shall be of the tight-closing, rubber seated type, with rubber seat positively locking in place sealing against flow from either direction. Valves shall be hand operated with cast or ductile iron bodies. Valves shall conform to the requirements of AWWA C504, Class 150B, and shall be fusion-bonded epoxy coated per ANSI/AWWA C550.
2. Valves shall have a 2-inch (50 mm) square operating nut and shall be installed with extension stems to extend the operating nut in accordance with the project details. Valves shall open by turning the operating nut counter clockwise unless specified otherwise in the Plans or [Fulton County Technical Specification for Water Main Construction].
3. Valve shafts shall be of 304 or 316 stainless steel.
4. Buried butterfly valve end connections shall be installed using restrained mechanical joints.
5. Flanged valves shall be fully faced and drilled in accordance with ANSI Standard B16.1, Class 125.
6. Provide brass identification tag imprinted with “WATER”, valve size, valve type, and direction and number of turns to open. Provide a ¼-inch (8 mm) hole in the brass tag and attach the tag to the end of the locate wire (twist wire around tag). Tag shall be 2-inch (50 mm) diameter and ⅛-inch (6 mm) thick brass with a ¼-inch (8 mm) hole.

K. Ball Valves

1. Ball valves 2-inch (50 mm) and smaller shall be designed for a working pressure of not less than 175 psi. End connection shall be threaded. The body and all parts shall be made in accordance with AWWA C800 and ASTM B62 latest revision.

L. Tapping Sleeves and Valve Assembly

1. Tapping sleeves and valves sizes 4-inches (100 mm) and larger shall be stainless steel with wraparound gasket style, or ductile iron of the split-sleeve, mechanical joint type. Tapping sleeves shall be rated for a minimum 150 psi working pressure in accordance with ANSI/AWWA C110/A21.10.
2. When tapping an existing asbestos cement pipe, a stainless steel tapping sleeve which contains a full gasketed surface within the sleeve body shall be used due to variances in the manufactured outside diameter of the asbestos cement pipe.
3. Tapping sleeve shall have an outlet flange per ANSI B16.1, Class 125 standard.
4. The Contractor shall determine the outside diameter of the existing main before ordering the sleeve.
5. Tapping valves shall be mechanical joint outlet, non-rising stem, resilient seated gate valves meeting the applicable requirements of ANSI/AWWA C509/C515 and C550 with a minimum design working pressure of 200 psi.
6. Tapping valves shall be specifically designed for pressure tapping with sufficient seat opening to allow full diameter taps to be made.

7. Tapping valves shall be manufactured with an integral tapping flange having a raised lip design.
8. Tapping valves shall be furnished with a combination flange and mechanical joint for connecting the branch to the main.

M. Valve Boxes

1. All valves shall be equipped with valve boxes. The valve boxes shall be heavy, roadway type boxes. The valve box cover shall be marked “WATER VALVE” or “WATER”.
2. Valve box materials shall conform to the requirements and standards set forth in the [Fulton County Technical Specification for Water Main Construction], current published edition.
3. The valve boxes shall be adjustable up or down from the nominal required cover over the pipe. Extensions shall be provided as necessary. A precast concrete ring shall be placed around the valve box opening when outside of paved areas.
4. Valves shall be furnished with extension stems as necessary to bring the operating nut to within 24 inches (600 mm) minimum of the top of the valve box.

N. Service Connection Assemblies

1. Water service connections and plumbing should conform to the standards set forth in the [Fulton County Technical Specification for Water Main Construction] and relevant local and/or state plumbing codes or to the Standard Plumbing Code as applicable within the jurisdiction in which the system is located.
2. Service connection assemblies shall be provided for all new service line connections to existing meters. Existing service lines indicated for replacement shall be replaced with new materials from the water main to the existing or new water meter.
3. Service connection assemblies shall include:
    a. Service saddle
    b. Corporation stop
    c. Service line
    d. Fittings
    e. Curb stop
    f. Water meter box
    g. Water meter (separate Pay Item for new service connections)
    h. Backflow preventer (separate Pay Item for new service connections)

O. Service Saddles

1. Service saddles shall have ductile iron or bronze body with stainless steel epoxy coated double tie straps and nuts with pressure rating not less than that of the pipe to which it is to be connected.
2. Saddles shall have a rubber gasket cemented to the body, with compatible threading between the saddle and corporation stop. Saddles shall conform to ANSI/AWWA C800 standards.
3. The service saddle shall provide full support around the circumference of the pipe, providing a bearing area of sufficient width so that pipe will not distort when the saddle is tightened.

P. Water Service Pipe

1. Polyethylene (PE) pipe for water service lines shall conform to AWWA C901 and ASTM D-2737 and shall be 200 psi pipe, SDR 9 for copper tube size (CTS). Polyethylene extrusion compound from which the polyethylene pipe is extruded shall comply with applicable requirements for PE 3408 ultra-high molecular weight polyethylene plastic material as specified in AWWA C901.
2. Marking on the PE service pipe shall include the nominal pipe or tubing size, the type of plastic material, the standard thermoplastic pipe dimension ratio or the pressure rating in psi, the ASTM designation with which the pipe

complies, and manufacturer's name or trade mark and code. It shall also include the NSF seal of approval for use with potable water.

3. Copper tubing for water service lines shall be seamless and shall conform to ANSI/AWWA C800 and ASTM B88, Type K soft, suitable for potable water use with a working pressure of 150 psi.
4. Water service line fittings shall be as indicated in [Fulton County Technical Specification for Water Main Construction].

Q. Corporation and Curb Stops

1. Corporation stops, curb stops, and other appurtenances for plastic or copper service lines shall meet the requirements of ASTM B62 and AWWA C800.
2. Service line taps shall be equipped with corporation stops. Corporation stops in sizes 1-inch (25 mm) through 2-inch (50 mm) shall be manufactured from cast bronze with machined fitting surfaces. The corporation shall be pressure rated to no less than 150 psi.
3. Curb stops shall be ball valve type and made of bronze. Pipe connections shall be suitable for the type of service pipe used and shall be pressure rated for no less than 150 psi.

R. Water Meters

1. Water meters shall conform to the requirements and standards set forth in the [Fulton County Technical Specification for Water Main Construction].

S. Meter Boxes

1. Water meter boxes shall be high density reinforced plastic body with one piece cast iron lid with lettering “WATER METER” on cover unless otherwise indicated on the Plans. Recessed hole shall be included in lid, if required by Utility Owner for electronic reading capability. Provide box of size and height appropriate to installation of meter and accessories required. Meter and curb stop shall be fully encased by the meter box.

T. Concrete Vault

1. Concrete vaults shall conform to the requirements and standards set forth in the [Fulton County Technical Specification for Water Main Construction] and standard details.

U. Air Release Valve Assembly

1. Air release, air/vacuum valves, and combination air valves shall be suitable for use with potable water systems and manufactured in compliance with ANSI/AWWA C512.
2. Air release valves shall have a small venting orifice to vent the accumulation of air and other gases in the line or system under pressure.
3. Air/vacuum valves shall have a large venting orifice to permit the release of air as the line is filling or relieve the vacuum as the line is draining or is under negative pressure.
4. Combination air valves shall have operating features of both the air/vacuum valve and air release valve.
5. Valves shall be suitable for pressures up to 250 psi.
6. Air release, air/vacuum valves, and combination air valves shall conform to the requirements set forth in the [Fulton County Technical Specification for Water Main Construction] and standard details.

V. Fire Hydrant Assembly

1. Fire hydrants shall be the compressive, post style, dry barrel type, and shall conform to the requirements of ANSI/AWWA C502 and local code requirements. The valve opening shall not be less than 4½-inch (115 mm). All hydrants shall be complete including joint assemblies.
2. Hydrants shall be suitable for working pressure of 150 psi and shall be hydrostatically factory tested to 300 psi.
3. All working parts, including the seat ring, shall be removable through the top without excavating or disturbing the barrel of the hydrant.

4. Hydrants shall be constructed with a lubricant chamber which encloses the operating threads and which provides automatic lubrication of the threads and bearing surfaces each time the hydrant is operated. This assembly shall be comprised of a top O-ring serving as a dirt and moisture barrier and a lower O-ring which will serve as a pressure seal.
5. Hydrants shall include two 2½-inch (65 mm) hose nozzles and one 4½-inch (115 mm) pumper connection with National Standard Fire Hose Threads unless specified otherwise in the Plans or [Fulton County Technical Specification for Water Main Construction]. Hydrant threads shall comply with the specifications of the local agency providing fire service.
6. Hydrant nozzle shall be constructed to face in any direction at any time by removing the safety flange bolts and revolving the head without digging or shutting off water.
7. Hydrants shall have pentagon operating nut measuring 1½-inch (40 mm) point to flat and shall open by turning counter-clockwise.
8. Hydrant shall have a safety-type vertical barrel with a minimum 3½-foot bury and be designed with safety flange and/or bolts to protect the barrel and stem from damage, eliminate flooding, and allow rapid replacement if hydrant is struck. All risers necessary for deeper bury applications shall be provided by the hydrant manufacturer.
9. Hydrants shall include positive, automatic drain valves which shall be fully closed when the main valve is open.
10. Bottom inlet of hydrant shall be provided with mechanical joint connection complete with accessories as specified and shall be 6-inch (150 mm) nominal diameter.
11. Fire hydrant shall be painted above ground with rust inhibiting enamel paint in accordance with [Fulton County Technical Specification for Water Main Construction].
12. Hydrant assemblies shall be restrained from the hydrant to the tee at the main.

W. Backflow Prevention Devices

1. Backflow prevention devices shall be installed where indicated on the Plans and shall meet all applicable AWWA, State, and local code/ordinance requirements.
2. Backflow preventer materials shall conform to the requirements and standards set forth in the [Fulton County Technical Specification for Water Main Construction].

X. Thrust Collars and Thrust Blocks

1. Concrete used for thrust collars or thrust blocks shall meet the "Class A" requirements for concrete listed in Section 500.
2. Thrust collars shall include welded-on collars attached by the pipe manufacturer or retainer glands. Concrete shall be poured continuous around the pipe and bear against undisturbed earth.
3. Reinforcing steel shall meet the requirements set forth in the Plans or [Fulton County Technical Specification for Water Main Construction].
4. Mechanical joint restraints shall be utilized in lieu of thrust blocks with the approval of Utility Owner.

Y. Manholes

1. Precast reinforced manholes shall be manufactured in accordance with ASTM C478 and shall have a minimum wall thickness of 5 inches (127 mm). All concrete shall have a minimum compressive strength of 4,000 psi when tested in accordance with ASTM C478.
2. Joints between precast sections shall be sealed by means of rubber O-ring gaskets or flexible butyl rubber sealant.
3. Non-shrinking grout or a flexible seal shall be used to seal the pipe penetrations and prevent water from entering the manhole.
4. Manhole rings and cover shall be per the [Fulton County Technical Specification for Water Main Construction] and standard details.

670.2.02 Delivery, Storage, and Handling

A. Handle pipe, fittings, valves, and accessories carefully to prevent damage. Handle pipe by rolling on skids, forklift, or front end loader. Do not use material damaged in handling. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior coatings or internal lining of the pipe. Do not use chains in handling pipe, fittings, or appurtenances.

B. To unload pipe, carefully lift and lower it into position using approved padded slings, hooks, or clamps. Furnish equipment and facilities for unloading, handling, distributing, and storing pipe, fittings, valves, and accessories. Make equipment available at all times for use in unloading. Do not roll, drop or dump materials. Any materials dropped or dumped shall be subject to rejection without additional justification.

C. Stored materials including salvaged materials shall be kept in suitable areas safe from damage. The interior of all pipe, fittings, and other appurtenances shall be kept free from dirt or foreign matter at all times. Store and support plastic pipe to prevent sagging and bending. Store plastic pipe and gaskets to prevent exposure to direct sunlight. Valves and hydrants shall be stored and protected from damage by freezing.

D. Pipe shall not be stacked higher than the limits recommended by the manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete.

670.3 Construction Requirements

670.3.01 Personnel

A. General Provisions 101 through 150.

B. Construction and installation of all water utilities shall be performed by a Contractor prequalified/registered with GDOT.

C. All work specified in this section, except for water system service line installation shall be performed by a Contractor with a valid Utility Contractor's license issued by the State of Georgia. Water service line installation shall be performed by either a Utility Contractor licensed in the State of Georgia or by a Master Plumber licensed in the State of Georgia.

670.3.02 Equipment

A. Ensure all equipment used is in conformance with the requirements and standards set forth in the [Fulton County Technical Specification for Water Main Construction], current published edition.

670.3.03 Preparation

General Provisions 101 through 150.

670.3.04 Fabrication

General Provisions 101 through 150.

670.3.05 Construction

A. Finding Existing Underground Utilities and Obstructions

1. Comply with Subsection 107.13 and Subsection 107.21.
2. According to the best information available to GDOT, all known water lines, sewer lines, gas lines, telephone conduits, drainage structures, etc. are shown on the Plans. However, to find such installations, use an electronic pipe and cable finder in locating existing installations or obstructions to the work.
3. When unforeseen conflicts require Plan changes, perform the work as altered according to Subsection 104.03 and Subsection 104.04.
4. Follow all Utility Owner customer notification requirements and obtain approval from the Utility Owner and GDOT Project Manager prior to disrupting any existing water services as required to install the water facilities shown on the Plans.

B. Jack and Bore

Comply with Section 615 for sewer main installations by jack and bore.

C. Directional Drilling

1. Install water mains and services by means of directional drilling at locations shown on the Plans or where approved by GDOT or Utility Owner. Provide submittals and follow all relevant procedures and requirements set forth in the [Fulton County Technical Specification for Water Main Construction].
2. The Contractor shall not initiate horizontal directional drilling until all submittals are received, reviewed, and accepted by GDOT and the Utility Owner, and all required permits are obtained.
3. The Contractor shall select drilling additives and fluid mixture proportions to ensure continuous circulation, bore stability, reduce drag on the pipe, and completely fill the annular space between the bore and the pipe to ensure stability and control settlement.
4. The Contractor shall submit contingency plans for remediation of potential problems that may be encountered during the drilling operations. The contingency plans shall address the observations that would lead to the discovery of the problem and the methods that would be used to mitigate the problem. Potential problems that shall be addressed include:
    a. Loss of returns/loss of circulation of drilling fluid.
    b. Encountering obstruction during pilot bore or reaming/pullback.
    c. Drill pipe or product pipe cannot be advanced.
    d. Deviations from design line and grade exceed allowable tolerances.
    e. Drill pipe or product pipe broken off in borehole.
    f. Product pipe collapse or excessive deformation occurs
    g. Utility strike.
    h. Hydrolock occurs or is suspected.
    i. Excessive ground settlement or heave of ground surface or existing utilities.
    j. Inadvertent returns / hydrofracture or surface spills resulting in drilling fluids entering water or reaching the surface.
5. Pipe damaged in directional drilling operations shall be removed and replaced at no additional expense to GDOT or the Utility Owner.
6. Voids developed or encountered during the installation operation shall be pressure grouted with a grout mix approved by GDOT.
7. Installation shall include a locatable conduit system, with identification markers on each side of GDOT right-of-way where applicable. Two (2) insulated 8 gauge solid copper tracers wire shall be attached to the leading end of the pipe pulling head and shall extend the full length of the installed pipe.
8. The location and alignment of the pilot drill progress shall be continuously monitored for compliance with the proposed installation alignment and for verification of the depth of the bore. Monitoring shall be accomplished by computer generated bore logs which map the bore path based on x, y, z coordinate information provided by the locating/tracking system. Readings or plots shall be obtained on every drill rod, and shall be provided to the Inspector on a daily basis. Deviations between the recorded and design bore path shall be calculated and reported on the daily log. If the deviations exceed tolerances specified elsewhere, such occurrences shall be reported immediately to GDOT. The Contractor shall undertake all necessary measures to correct deviations and return to design line and grade.
9. Upon completion of the directional drill the Contractor shall furnish GDOT and the Utility Owner an as-built drawing along with a report of the monitoring of the drilling fluids during the pilot hole and back reamed hole.
10. Drilling fluid pressures, flow rates, viscosity, and density shall be monitored and recorded by the Contractor. The pressures shall be monitored at the pump. These measurements shall be included in daily logs submitted to GDOT. The Contractor shall document modifications to the drilling fluids, by noting the types and quantities of drilling fluid

additives and the dates and times when introduced. The reason for the addition of drilling fluid additives or other modifications shall be documented and reported.

11. Management and disposal of drilling fluids shall be the Contractor's responsibility. Excess drilling fluids shall be contained at the entry and exit points until recycled or removed from the site. All drilling fluids shall be disposed of in a manner acceptable to the appropriate local, state and federal regulations. The Contractor's work will be immediately suspended by GDOT whenever drilling fluids seep to the surface other than in the boring entrance or exit pit, or when a paved surface is displaced.
12. Surfaces damaged by the work shall be restored to their preconstruction conditions at no additional cost to GDOT or Utility Owner, and with no increase in contract time.
13. The following items shall be as shown on the Plans, unless otherwise approved in writing by GDOT:
    a. Entry / exit points
    b. Drill entry / exit angles
    c. Pilot bore path
        1) Radius of Curvature
        2) Entry / exit tolerances: Contractor shall be solely responsible for all work necessary to correct excessive deviations from line and grade, including re-drilling, redesigning connections, and acquiring additional easement, at no additional cost to GDOT or Utility Owner and without schedule extension.
14. The pilot bore shall be pre-reamed and reamed using equipment and methods submitted by the Contractor. The Contractor shall completely ream the bore to the final diameter prior to pullback.
15. Pullback: The pipe shall be installed by pulling it into the reamed bore path in a continuous operation, behind a final reaming tool selected by the Contractor. The pipe shall be isolated from excessive torsional and axial stresses by a swivel device with a pre-established breakaway tensile capacity that is lower than the allowable tensile strength of the pipe. The maximum pull (axial tension force) exerted on the pipelines shall be measured continuously and limited to the maximum allowed by the pipe manufacturer with an appropriate factor of safety so that the pipe or joints are not overstressed. The end of the pipe shall be closed during the pull back operation.
16. Pipelines shall be adequately supported during installation so as to prevent overstressing or buckling. The Contractor shall provide adequate support/rollers along the pipe layout area to support the required length of pipe for the bore. The pipe layout area shall be cleared of all large stones, construction debris, or other foreign objects that could damage the pipe during pullback. The Contractor shall monitor and inspect pipe rollers and method for suspending pipe at entry during the pullback operation to avoid damage to the pipe.
17. The end of the pipe shall be closed during the pull back operation.
18. Each length of pipe shall be inspected and cleaned as necessary to be free of debris immediately before joining.
19. The Contractor shall at all times handle the pipe in a manner that does not overstress or otherwise damage the pipe. Vertical and horizontal curves shall be limited so that wall stresses do not exceed 50% of yield stress for flexural bending of the pipe. If the pipe is buckled or otherwise damaged, the damaged section shall be removed and replaced by the Contractor at his expense. The Contractor shall take appropriate steps during pullback to ensure that the pipe and tracer wires will be installed without damage.
20. If necessary, the pipe shall have water added as it enters the bore to achieve neutral buoyancy and reduce pullback loads and to ensure that adequate internal pressure is maintained at all points to counter balance collapse pressures.
21. The Contractor shall cease pullback operations if the pipe is damaged and shall remove the pipe from the bore and repair the pipe using the manufacturer's recommended procedure or replace the damaged pipe before resuming installation.
22. Damage to the pipe resulting from manufacturer defects, installation, or grouting is the responsibility of the Contractor, including costs for replacement and labor and materials. To confirm no damage to the pipe, upon completion of pull back, the Contractor shall pull a sphere or pig through the entire length of the pipeline. The pig shall be one inch less in diameter than the internal diameter of the product pipe, capable of allowing water to pass

through it, complete with a pulling cable on either side. If the pig or sphere cannot pass through the pipe, it shall be considered collapsed and damaged.

23. After the carrier pipe is completely pulled through the bore, a sufficient relaxation period as recommended by the pipe manufacturer shall be provided before the final pipe tie-in.
24. The Contractor shall conduct a final hydrostatic test of the installed pipeline. Final test shall be in accordance with these specifications. The Contractor shall repair any defects discovered during this test, and repeat until the pipe passes the test.

D. Excavating Trenches

1. The Contractor shall provide all necessary shoring and bracing materials as required to assure safe working conditions and to protect the excavations. The Contractor shall be required to fully comply with all applicable OSHA Excavation Safety Standards. No separate payment shall be made for any special procedure used in connection with the excavation.
2. Excavate trenches to the proper depth and width as follows:
   a. Trench to Grade: Excavated trench bottoms shall be firm, free from boulders, and conform to the established grade. Limit open trench excavation to a maximum of three 300 feet (90 m) ahead of completed backfill.
   b. Care shall be taken not to over excavate except where necessary to remove unstable material, irregularities, lumps, rock, and projections. Unnecessary over excavation shall be replaced at the Contractor's sole expense and in accordance with Subsection 670.3.05.
   c. Excavation carried below the established grade lines shown or established by the Utility Owner shall be backfilled according to Section 207 and Subsection 670.3.05. Use Class I or Class II Soils (defined in Section 810) and firmly compact the soil.
   d. Where the established grade of a trench is in rock, undercut the bottom of the trench by at least 6 inches (150 mm) beneath the pipe or conduit and the greater of 24 inches (600 mm) wider than the pipe/conduit (12 inches or 300 mm each side) or 42 inches (1050 mm) wide, then backfill and compact according to Subsection 670.3.05.
   e. Excavation in pavement and pavement patching shall be according to GA Standard No. 1401. Remove the pavement according to Section 444, except no separate payment shall be made for sawed joints.
   f. Dewatering: Remove all water from excavations and maintain the excavations free of water while construction therein is in progress. Provide dewatering equipment as necessary to conform to this requirement. Dewatering procedures must meet all state and local regulatory requirements.
3. Minimum Trench Depth
   a. Excavate trenches to provide at least 48 inches (1.2 m) cover depth directly above the pipe to the finished pavement surface, sidewalk, grass, etc. unless indicated otherwise on the Plans or by the Utility Owner and GDOT Project Manager. In order to avoid existing utilities, it may be necessary for the pipe to be laid shallower or deeper than the minimum cover specified. At such time the Contractor shall not be allowed extra compensation for additional excavation necessary for deeper installations.
   b. Side slopes of the trenches shall be as nearly vertical as practicable. Trenches in excess of 5 feet (1.5 m) deep shall either have the trench sides laid back to conform to OSHA requirements for trench safety, if such area is available within the limits of excavation, or, alternatively, trenches deeper than 5 feet (1.5 m) shall be excavated via trench box or shored and braced.
   c. If any part of a water main is to be placed in or under a new embankment, finish the embankment to at least a 2-foot plane above the outermost portion of the pipe barrel before excavating the trench.

4. Trench Width: Excavate trenches to uniform widths wide enough to allow proper installation of pipe, fittings, and other materials, a minimum of 6 inches (150 mm) and a maximum of 12 inches (300 mm) each side of the pipe or conduit.
5. Trench Bell Holes: Excavate bell holes deeply and widely enough to make joints and to allow the pipe barrel to rest firmly on the trench bottom.
6. Trench bottom: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduits. Shape subgrade to provide continuous support of bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits/pipes. Remove projecting stones, tree roots, debris, and sharp objects along trench subgrade. Abrupt changes in grade of the trench bottom shall be avoided. Unless otherwise indicated in the Plans or [Fulton County Technical Specification for Water Main Construction], trenches for water mains shall be graded as much as possible to avoid high and low points that necessitate air release valves.
7. Excavations may be completed and refilled either by hand or by machinery. Hand tool excavation shall be conducted where necessary to protect existing utilities and structures.
8. In the event that unsuitable material is encountered at or below the excavation depth specified or shown on the Plans, the Utility Owner and GDOT Project Manager shall be notified. Such material shall be removed and replaced with suitable material in accordance with Section 205 by the written request of the GDOT Manager.

E. Connecting to Existing Mains

1. Connect to an existing main with the appropriate fittings according to the Plans or the Utility Owner and GDOT Project Manager. When making connections under pressure, (i.e. when normal water service must be maintained), furnish and use a tapping sleeve and valve assembly or line stop fittings as indicated. Coordinate with Utility Owner 72 hours in advance for water service interruptions and temporary shut-offs. Evening or weekend work may be required to complete direct connections and tie-ins. Connect to existing mains as follows:
   a. Before opening new pipeline trenches, locate the various points of connection to be made into existing pipelines. If necessary, uncover pipelines for the Utility Owner and GDOT Project Coordinators to prescribe the connections and fittings needed.
   b. Connect to existing pipelines only to meet operating requirements. Cut existing lines only after obtaining the Utility Owner and GDOT Project Manager' permission.
   c. Provide temporary line stops, associated fittings, and bypass pumping as indicated on the Plans and as necessary when cutting and plugging existing water mains to prevent service interruptions. Line stop and associated fittings shall be suitable for working pressures of 250 psi.
   d. Connections to existing asbestos cement pipe shall be installed as indicated on the Plans or in [Fulton County Technical Specification for Water Main Construction]. Cutting, removing, handling, and disposing of asbestos cement pipe shall be in accordance with requirements established by EPA, OSHA, GDOT, NIOSH, and the State of Georgia Environmental Protection Division, and any other applicable laws and ordinances.

F. Laying Water Mains and Appurtenances

1. Preparing and Handling Pipes
   a. Thoroughly clean the pipe and fittings before laying them. Keep them clean until accepted.
   b. Use suitable tools and equipment. Do not damage the pipe, especially the cement lining inside the pipe.
   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. Bedding shall be provided as specified by the Utility Owner or pipe manufacturer for the type of conditions encountered. Bedding typically consists of granular soil free of lumps, clods, cobbles, and frozen materials, and shall be graded to a firm-but-yielding surface without abrupt changes in bearing value. Unstable soils and rock ledges shall be undercut from the bedding zone and replaced with suitable material.
   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 18-inch (450 mm) 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 10%.

g. Carefully examine pipe for cracks and other defects and do not lay defective pipe. If pipe or castings appear to be cracked, broken, or defective after laying, remove and replace those sections.

2. Alignment and Gradient

a. Pipe alignment and gradient shall conform to the Plans. Deflect pipe lines only where indicated on the Plans, within allowable horizontal and vertical deflection angles according to the manufacturer.

b. Water mains shall be laid at least 10 feet (3 m) horizontally from any existing or proposed sanitary sewer, storm sewer or sewer manhole. The distance shall be measured edge-to-edge. When local conditions prevent a horizontal separation of 10 feet (3 m), the water main may, on a case-by-case basis, be laid closer to a sewer provided the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches (450 mm) above the top of the sewer.

c. Maintain a vertical separation of at least 18 inches (450 mm) 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 18 inches (450 mm) 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.

3. Special Requirements for Laying Water Mains

a. Excavate, clean, lay, joint, and backfill progressively and uniformly according to these requirements:

1) Never leave pipe in the trench overnight without completely jointing and capping.

2) Do not leave completed pipeline exposed in the trench. Backfill and compact the trench as soon as possible after laying, jointing, and testing are complete.

3) At the close of work each day and when laying pipe, close the exposed end of the pipeline in the trench with an approved wood or metal head or barrier.

4) If necessary to cover the end of an incomplete pipeline with backfill, close the end of the pipe with a satisfactory cap or plug.

G. Installing Water Mains by Open Cut

1. Use the following flexible joints for connections inside the roadway shoulders or curbs and gutters:

a. Mechanical Joints:

1) When using mechanical joints, thoroughly wash bell sockets, spigots, gland, gasket, nuts, and bolts with soapy water before assembly. Keep these parts wet until the jointing operation is complete.

2) Tighten nuts within the torque range recommended by the manufacturer. Check the tightening tolerance with a torque wrench.

3) If effective sealing is not attained at the maximum recommended torque, disassemble, thoroughly clean, then reassemble the joint.

4) Do not overstress bolts to compensate for improper installation or defective parts.

b. Push-On Type Joints

1) Use push-on joints made according to the manufacturer’s recommendations.

2) Install PVC pipe in accordance with AWWA C605.

3) Install ductile iron pipe in accordance with AWWA C600.

2. Restraints for pipe joints and fittings shall be provided as specified and as shown on the Plans. Restraints shall be installed per manufacturer's recommendations.
3. Buried ductile iron pipe and fittings shall be polyethylene encased as specified and as indicated on the Plans. Polyethylene encasement tubing shall be secured with polyethylene tape and installed in accordance with ANSI/AWWA C105/A21.5.
4. Unless otherwise specified by [Fulton County Technical Specification for Water Main Construction], provide pipe detection wire on all non-metallic pipe systems. Tape the tracer wire to the top center of the pipe at intervals which prevent wire displacement during backfilling operations. Stub tracer wire up 6 inches (150 mm) above finished grade at all valves and fire hydrants. For splices, use direct bury kits. After backfilling is complete, test electrical continuity of each tracer wire segment and provide test results to Utility Owner and GDOT Project Manager.
5. Install continuous underground warning tape during backfilling of trench for underground water distribution piping. Install 12 inches (300 mm) below finished grade, or 6 inches (150 mm) below subgrade under pavements and walkways, and buried directly over piping.
6. Use pipe cutters when cutting pipe or special castings. Do not use a hammer, chisel, or a cutting torch.
7. Locations where water mains do not meet minimum depth of cover requirements shall include a steel casing or concrete encasement installed per [Fulton County Technical Specification for Water Main Construction].
8. If HDPE pipe is to be installed where high groundwater table or water surrounding the pipe is expected, precautions shall be taken to provide neutral buoyancy to prevent floatation or a change in alignment.
9. Isolation Valves on Water Mains: Install and joint gate and butterfly valves as specified in Subsection 670.2.01 in accordance with AWWA C600. Include the valve box and valve marker where required.
10. Air release valves shall be located at high elevation points on the pipeline. Air release valves shall be installed at locations indicated in the Plans and in accordance with manufacturer's recommendations.
    a. Air release valves shall be installed in a shallow manhole or vault as indicated in the Plans and [Fulton County Technical Specification for Water Main Construction]. Automatic air relief valves shall not be used in areas where flooding of the manhole or vault may occur.
    b. An isolation valve shall be installed between the air release assembly and the connection to the main.
    c. The Contractor shall furnish and install at no additional cost to GDOT or Utility Owner all necessary fittings for the installation of air release valves at high points.
11. Pressure reducing/sustaining valves of the size and type indicated shall be installed as shown on the Plans per manufacturer's recommendations and [Fulton County Technical Specification for Water Main Construction].
12. Fire Hydrants: Install and joint hydrants as specified in Subsection 670.2.01 and in accordance with AWWA C600. Include required vertical extension sections. Also, include pipe strap installation, restraints, crushed stone drain, and backfill according to the Plans and this Section. Spacing of fire hydrants shall be as indicated in [Fulton County Technical Specification for Water Main Construction].
13. Concrete Thrust Collars and Thrust Blocks: If required, furnish materials and install thrust collars or concrete blocking according to Subsection 670.2.01. Form and pour concrete thrust collars or blocks in accordance with the Plans and the [Fulton County Technical Specification for Water Main Construction]. Blocking shall be poured against undisturbed earth and all forms shall be removed before backfilling.
14. Backfilling
    a. Furnish equipment, labor, and when necessary material required for backfilling the pipe line trenches according to Section 207, and as follows:
        1) When testing for visual leaks in open trenches, do not backfill until testing is complete and leaks are eliminated.
        2) When retaining pavement adjacent to trenches, replace removed pavement with the same or better material when approved in accordance with the appropriate Section for the pavement type replaced.

3) Place backfill on subgrades free of mud, frost, snow, or ice.

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

5) Backfill shall include Class I or Class II Soils as defined in Section 810 or suitable material that conforms with [Fulton County Technical Specification for Water Main Construction].

6) Backfill shall be placed in two stages: first, side fill to a height of 12 inches (300 mm) above the top of pipe; second, overfill to former surface grade. Side fill shall consist of granular material laid in 6-inch (150 mm) layers each consolidated by mechanical tamping and controlled addition of moisture, to a density of 95% as determined by as determined by the Standard Proctor test (AASHTO T-99 Method D) or GDT 67. Overfill shall be layered and consolidated to match the entrenched material in cohesion and compaction. The top 12 inches (300 mm) shall be compacted to 100% of specified density. Consolidation by saturation or ponding shall not be permitted.

7) Soil Moisture Control: Uniformly moisten and aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2% of optimum moisture content. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2% and is too wet to compact to specified dry unit weight.

8) Initial backfill shall be carefully compacted under pipe haunches and evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Place and compact fill and backfill of satisfactory soil to final subgrade elevation. Backfill voids with satisfactory soil while removing shoring and bracing and/or trench boxes.

9) After backfilling, maintain temporary surface restoration per GA Standard No. 1401 until permanent repaving is complete. No separate payment shall be made for replaced pavement.

15. Disinfection of Water Mains

a. New and existing pipelines and appurtenances shall be disinfected before placing into service. Disinfection can be conducted in conjunction with the pressure test.

b. Before the main is chlorinated, it shall be filled to eliminate air pockets and shall be flushed to remove particulates.

c. During disinfection of the water mains, an appropriate cross-connection control device, consistent with the degree of hazard, shall be provided for backflow protection of the active distribution system.

d. Chlorination: Sterilize using only potable water with calcium hypochlorite (HTH), 1% chlorine solution, or other products acceptable to the Utility Owner and GDOT Project Manager and Department of Public Health. Comply with AWWA C651 including Section 9 procedures on final connections to existing mains.

1) The chlorine solution used for disinfection of water mains shall have a free chlorine residual concentration not less than 25 mg/L or in accordance with [Fulton County Technical Specification for Water Main Construction].

2) Add enough disinfectant to provide a chlorine residual of not less than 10 parts per million (ppm) in 24 hours or as required in [Fulton County Technical Specification for Water Main Construction]. All valves and hydrants shall be operated to ensure disinfection of the appurtenances.

3) At the end of 24 hours, check the chlorine residual. If it is less than 10 ppm, add additional chlorine and check the line again after 24 hours.

e. After the applicable retention period, the chlorinated water must not be disposed in a manner that will harm the environment. Neutralizing chemicals, such as Sulfur Dioxide, Sodium Bisulfite, Sodium Sulfite or Sodium Thiosulfate can be used to neutralize the chlorine residual remaining in the water to be wasted.

f. After sterilization, flush the line with potable water until the chlorine residual is equal to the existing system.

1) After final flushing and before the water main is placed into service, water samples shall be collected from the main and tested for microbiological quality in accordance with the Georgia Rules for Safe Drinking Water. Samples shall be taken in the presence of the Utility Owner and GDOT Project Manager.
2) When test results are not satisfactory, the pipeline shall be flushed and disinfected again as necessary without additional compensation until satisfactory results are obtained.

H. Laying Service Lines and Appurtenances

1. Except as modified in this Section, construct and install service connection assemblies and lines according to the Plans and the requirements for laying water mains. Install service lines at locations shown on the Plans or where designated by the Utility Owner and GDOT Project Manager.
2. Install new pipe from the water main to the final location of the meter or to points designated by the Utility Owner and GDOT Project Manager to connect with existing or future service lines on abutting property.
3. No water service connections shall be performed until the main is tested and disinfected. Water service lines shall be tested and disinfected prior to connection to the main.
4. If required, install water service line inside casing pipe according to the Plans or [Fulton County Technical Specification for Water Main Construction].
5. At roads, paved drives, retaining walls, and other paved areas, install service tubing or casing pipe by pushing, pulling, or augering techniques. At all other locations, install service tubing by trenching and backfilling unless directed otherwise by GDOT.
6. Service line installation includes all connections using saddles, unions, valves, fittings, corporation stops, curb stops, casing, and any and all appurtenant work required to provide a complete water service connection.
7. Excavate for service lines as specified in Subsection 670.3.05 with the following exceptions:
   a. Ensure that trenches under pavements and across driveways are deep enough to provide at least 48 in (1.2 m) of cover, unless otherwise specified by [Fulton County Technical Specification for Water Main Construction] or directed by the Utility Owner and GDOT Project Manager.
   b. At other areas, trench depth and backfill cover may be adjusted at the discretion of the Utility Owner and GDOT Project Manager to provide at least 18 in (450 mm) of cover.
8. Backfill service lines as specified in Subsection 670.3.05.
9. All service lines, fittings, and appurtenances necessary for the water service connections shall be installed and backfilled in accordance with the manufacturer's recommendations and as per [Fulton County Technical Specification for Water Main Construction] and standard details.

I. Cutting and Capping Existing Water Mains

1. Disconnect by sawing or cutting and removing a segment of existing pipe where cutting and capping or plugging is shown on the Plans or directed by the Utility Owner or GDOT Project Manager. Provide a watertight pipe cap or plug and restraint mechanism to seal off existing mains indicated to remain in service. If water main is to be abandoned or removed and not specified to be grout filled, seal ends with a pipe cap or plug or with a masonry plug and minimum 6-inch (150 mm) cover of concrete on all sides around the end of the pipe.
2. The Contractor shall be responsible for uncovering and verifying the size and material of the existing main to be capped or plugged.
3. Abandoned manholes and water mains greater than 6-inch (150 mm) shall be filled with flowable fill per Section 600 at the locations indicated on the Plans. Air release valves and water service connections along the abandoned main shall be plugged prior to grouting. Prior to backfilling, the bottom of the manhole shall be broken up in such a manner that water will readily pass through. The top portion of the manhole structure shall be removed in order to establish a minimum of 3 feet cover from subgrade or finished grade when not under the pavement and filled with sand or suitable backfill.

4. Water mains shall be flushed prior to placement of flowable fill. Use concrete or grout pumps capable of continuous delivery at planned placement rate with sufficient pressure to overcome friction and fill the sewer main.

J. Relocating, Adjusting, and Removing

1. Fire Hydrant Assemblies
   a. Relocate, adjust to grade, or remove fire hydrant assemblies including valve and valve boxes according to the Plans or as designated by the Utility Owner and GDOT Project Manager.
   b. Protect items during removal and relocation. Replace lost or damaged Items at no expense to GDOT or the Utility Owner.
   c. Disconnect each joint before removing items from the trench.
   d. Install relocated fire hydrant assemblies with tapping sleeve, and as specified herein for new fire hydrant assemblies.
   e. Test for leakage, adjust, and retest until no leaks appear.
   f. Backfill as specified in Subsection 670.3.05.
   g. Consider valve boxes part of the valve assembly and remove them intact with the valve.
2. Water Valves and Boxes
   a. Adjust or remove water valves and valve boxes according to the Plans or as designated by the Utility Owner and GDOT Project Manager.
   b. Protect items during adjustment or removal. Replace lost or damaged Items at no expense to GDOT or the Utility Owner.
   c. Disconnect each joint before removing items from the trench.
   d. Test for leakage, adjust, and retest until no leaks appear.
   e. Backfill as specified in Subsection 670.3.05.
   f. Consider valve boxes part of the valve assembly and remove them intact with the valve.
3. Existing Water Meters and Boxes
   a. Relocate existing water meters and boxes according to the Plans or the Utility Owner and GDOT Project Manager.
   b. To relocate water meters, remove the existing meter, associated backflow preventer, and box and replace with a short section of pipe.
   c. Inspect along with the Utility Owner and GDOT Project Manager each meter and backflow preventer before removal to determine the condition of each.
   d. Unless specified otherwise in the Plans or [Fulton County Technical Specification for Water Main Construction], new water meters and backflow preventers shall be furnished by the Contractor as necessary if these devices are deemed unsuitable for reuse. Contractor shall provide new water meter boxes if deemed unsuitable for reuse. The Contractor shall coordinate delivery of the water meters and backflow preventers to correspond to construction operations to minimize service interruptions.
   e. Relocation of water meters and boxes shall include without additional compensation, required pipe, unions and appurtenances, adapter fittings, necessary storage protection, and installation of meter, backflow preventer, meter box, and curb stop in the existing service line.
4. Existing Water Service Lines
   a. Water lines shall be adjusted to grade by excavating the existing lines, lowering or raising the lines, and backfilling according to the Plans or the Utility Owner and GDOT Project Manager.
   b. Furnish new materials or fittings required for the adjustment without additional compensation.
   c. Change connections at the main that result from this work.
   d. Repair leaks and damage caused by the operations at no expense to GDOT.
   e. When retaining a water meter where an existing service line is to be adjusted, adjust the existing meter and box to the proper grade without additional compensation.
5. Other Water Appurtenances

a. Relocate, adjust to grade, or remove water main appurtenances including but not limited to air release valves, backflow preventers, pressure reducing/sustaining valves according to the Plans or as designated by the Utility Owner and GDOT Project Manager.

6. Utility related items identified on the Plans to be salvaged are the property of the Utility Owner. Contractor shall coordinate with Utility Owner on delivery of salvaged materials. Should the Utility Owner choose to not accept these materials they shall be removed from the project site as soon as practical.

K. Aerial Crossings

1. Support must be provided for all joints in pipes utilized for aerial crossings. The supports must be installed to prevent frost heave, overturning, and settlement. Precautions against freezing, such as insulation, shall be provided.
2. When the aerial crossing is accomplished by attachment to a bridge or drainage structure, the crossing shall meet all requirements of the agencies that own or have jurisdiction over such structures.
3. Aerial installations shall be installed to avoid or minimize stream blockage during normal high water events.
4. Underground valves shall be provided at both ends of the aerial crossing so that the section can be isolated for testing or repair. The valves shall be restrained, easily accessible, and not subject to flooding. An air release/vacuum relief valve shall be installed at all high points along the aerial crossing.
5. Appropriate guards shall be installed at both ends of the aerial crossing to prevent public access to the pipe.

670.3.06 Quality Acceptance

A. Materials Certification

For certain products, assemblies and materials, not on GDOT QPL List, and in lieu of normal sampling and testing procedures by the Contractor, the Utility Owner, and GDOT may accept from the Contractor the manufacturer's certification with respect to the product involved under the conditions set forth in the following paragraphs:

1. Material certifications shall be provided to GDOT, who shall distribute to the Utility Owner. Material certifications shall be approved by GDOT and the Utility Owner prior to construction. The certification shall state/specify that the named product conforms to these specifications and requirements of the Utility Owner and GDOT, and representative samples thereof have been sampled and tested as specified.
2. The certification shall either:
   a. Be accompanied by a certified copy of the test results, or
   b. Certify such test results are on file with the manufacturer and will be furnished to the Utility Owner and GDOT Project Coordinators upon demand.
3. The certification shall state/specify the name and address of the manufacturer and the testing agency and the date of tests; and sets forth the means of identification which shall permit field determination of the product delivered to the project as being the product covered by the certification.
4. Submit certification in triplicate with two copies of the covered product to the GDOT Project Coordinator, and one copy sent to GDOT's State Materials and Research Engineer at 15 Kennedy Drive, Forest Park, Georgia. The certification shall specify the project number and contract ID number. No certificate shall be required for Portland cement when furnished from a manufacturer approved by GDOT.
5. GDOT or the Utility Owner will not be responsible for any costs of certification or for any costs of the sampling and testing of products in connection therewith.
6. GDOT and the Utility Owner reserve the right to require samples and test products for compliance with pertinent requirements irrespective of prior certification of the products by the manufacturer. Any materials that fail to meet specification requirements will be rejected.
7. In accordance with the BUY AMERICA requirements of the Federal regulations (23 U.S.C. 313 and 23 CFR 635.410) all manufacturing processes for steel and iron products or predominantly of steel or iron (at least 90% steel

or iron content) furnished for permanent incorporation into the work on this project shall occur in the United States. The only exception to this requirement is the production of pig iron and the processing, pelletizing and reduction of iron ore, which may occur in another country. Other than these exceptions, all melting, rolling, extruding, machining, bending, grinding, drilling, coating, etc. must occur in the United States.

a. Products of steel include, but are not limited to, such products as structural steel piles, reinforcing steel, structural plate, steel culverts, guardrail steel supports for signs, signals and luminaires, and cable wire/strand. Products of iron include, but are not limited to, such products as cast iron frames and grates and ductile iron pipe. Coatings include, but are not limited to, the applications of epoxy, galvanizing and paint. The coating material is not limited to this clause, only the application process.

b. Records to be provided by the Contractor for this certification shall include a signed mill test report and a signed certification by each supplier, distributor, fabricator, and manufacturer that has handled the steel or iron product affirming that every process, including the application of a coating, performed on the steel or iron product has been carried out in the United States of America, except as allowed by this Section. The lack of these certifications will be justification for rejection of the steel and/or iron product or nonpayment of the work.

c. The requirements of said law and regulations do not prevent the use of miscellaneous steel or iron components, subcomponents and hardware necessary to encase, assemble and construct the above products, manufactured products that are not predominantly steel or iron or a minimal use of foreign steel and iron materials if the cost of such materials used does not exceed one-tenth of one percent (0.1%) of the total contract price or $2,500.00, whichever is greater.

B. Flushing

1. Prior to testing, water mains shall be cleaned and flushed to remove all sand and foreign matter. Water used for filling and cleaning shall be from an approved potable water source. Sufficient flushing water shall be introduced into the mains to produce a scouring velocity of not less than 3.5 feet per second to resuspend the solids, and this rate of flow shall be continued until the discharge is clear and no evidence of silt or foreign matter is visible. The Contractor shall dispose of all water used for flushing without causing a nuisance or property damage.
2. In the event that the Contractor cannot obtain the flushing velocity, a poly-pig swab may be used to clean the pipeline. The Contractor shall submit pigging plan to the Utility Owner and GDOT for review. The plan shall include type of pig material, water flow rate, discharge points, poly-pig detector and retrieval options.

C. Hydrostatic Testing of Water Mains

1. When the Utility Owner and GDOT Project Manager approve a section of pipe for testing, the Contractor shall furnish the materials, equipment, and labor to conduct the pressure and leakage tests. Use a test pump, pressure gauge, and a means of measuring the water necessary to maintain the required pressure during the prescribed testing time. All pressure and leakage testing shall be done in the presence of the Utility Owner and GDOT Project Coordinators as a condition precedent to the approval and acceptance of the system. All pipes shall have been thoroughly flushed prior to testing. Simultaneous or separate pressure and leakage tests may be performed.
2. All water for testing and flushing shall be potable water provided by the Contractor, at no cost to the Utility Owner or GDOT, from an approved source. Flow velocity during line filling shall not exceed 2 feet (0.6 m) per second (fps).
3. Testing Requirements
    a. Water mains shall be tested in sections between valves, thereby, testing each valve for secure closure. Testing shall be done immediately after installation and backfilling has been completed.
    b. The mains shall be tested in accordance with the latest revision of AWWA C600 for ductile iron and C605 for PVC under an average hydrostatic pressure of the greater of 1.5 times the maximum working pressure or 150 psi as measured at the lowest point in the system for a minimum of 2 hours. Pressure shall be maintained until all sections under testing have been checked for evidence of leakage.

c. While the system is being filled with water, air shall be carefully and completely exhausted. If permanent air vents are not located at all high points, the Contractor shall install corporation stops or fittings and valves at such points at no additional expense to the Utility so the air can be expelled as the pipe system is slowly filled.

d. Makeup water shall be added, as required, to maintain the pressure within 5 psi of the test pressure. The quantity used shall be measured by pumping from a calibrated container. The maximum amount of makeup water allowed shall be determined by the following formula:

$$L = \frac{SD\ P^{0.5}}{148{,}000}$$

in which,

L = Allowable Leakage in gallons per hour

S = Length of pipe being tested in feet

D = Nominal pipe diameter in inches

P = Average test pressure during the test in psi gauge

e. Visible leaks shall be corrected regardless of total leakage shown by test. All pipe fittings and other materials found to be defective under test shall be removed and replaced. Lines which fail to meet test requirements shall be repaired and retested as necessary until test requirements are met. No additional compensation shall be made for repairs or retesting.

670.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

670.4 Measurement

Incidentals including excavation, rock removal, backfilling, disinfection, testing, temporary water connections, pavement removal, pavement replacement, and other incidentals required for the installation of water distribution items are not measured for separate payment and shall be included in the applicable Pay Items below. Water mains, service lines, and other associated Items of work in this Specification, complete, in place, and accepted, are measured for payment as follows:

A. Ductile Iron Water Mains

Ductile iron water mains shall be measured in linear feet (meters) for each size, thickness class, and type (restrained, non-restrained) installed. Measurement shall be horizontally above the centerline of the pipe and shall include the length of valves and fittings.

B. PVC Water Main

PVC water mains shall be measured in linear feet (meters) for each size and type (restrained, non-restrained) installed. Measurement shall be horizontally above the centerline of the pipe and shall include the length of valves and fittings.

C. Fusible PVC Water Main

Fusible PVC water mains shall be measured in linear feet (meters) for each size and type installed. Measurement shall be horizontally above the centerline of the pipe and shall include the length of valves and fittings.

D. HDPE Water Main

HDPE water mains shall be measured in linear feet (meters) for each size and type installed. Measurement shall be horizontally above the centerline of the pipe and shall include the length of valves and fittings.

E. Ductile Iron Fittings

Ductile iron fittings are considered subsidiary to the water line in which they are used and are not measured for separate payment. This Item includes, but is not limited to, wyes, tees, bends, crosses, sleeves, plugs and caps, and reducers.

F. Restrained Joints

Joint restraints used with the installation of PVC or ductile iron pipe are considered subsidiary to the water line in which they are used and are not measured for separate payment.

G. Gate Valves

Gate valves shall be measured on an individual basis for each size valve and box assembly acceptably installed.

H. Butterfly Valves

Butterfly valves shall be measured on an individual basis on the number of each size valve and box assembly acceptably installed.

I. Tapping Sleeve and Valve Assembly

Tapping sleeve and valve assemblies shall be measured on an individual basis on the number of each size tapping sleeve and valve assembly acceptably installed.

J. Fire Hydrant Assemblies

Fire hydrant assemblies shall be measured on an individual basis on the number of hydrants acceptably installed.

K. Water Service Lines

Service lines shall be measured in linear feet (meters) for each size of service pipe installed. Measurements are made from end to end and from center of lines to ends of branches and include tapping saddle, sleeve, valves, service connection assemblies, sleeves, adapters, and fittings.

L. Air Release Valve Assembly

Air release valve assemblies shall be measured on an individual basis on the number of each size and type of air release valve assembly acceptably installed.

M. Blow-Off Assemblies

Blow-off assemblies shall be measured on an individual basis on the number of each blow-off assembly acceptably installed.

N. Backflow Prevention Device

Backflow prevention devices shall be measured on an individual basis on the number of each size and type backflow preventer acceptably installed.

O. Water Meter

Water meters shall be measured on an individual basis on the number of each size meter acceptably installed.

P. Steel Casing

Steel casing pipe of the wall thickness and diameter specified shall be measured by the linear foot for each size and thickness of steel casing pipe installed. Measurement shall be horizontally above the centerline of the casing.

Q. Relocation of Existing Fire Hydrant Assemblies, Air Release Valves, Water Meters, Backflow Preventers, and Pressure Reducing or Sustaining Valves

Relocation of existing fire hydrant assemblies, air release valves, water meters, backflow preventers, and pressure reducing or sustaining valves shall be measured on an individual basis on the number of each acceptably relocated including relocation and final adjustment of boxes.

R. Adjustment of Existing Meter Boxes and Valve Boxes to Grade

Adjustment of existing meter boxes and valve boxes adjusted to grade in their original locations shall be measured on an individual basis on the number of each acceptably adjusted in accordance with Section 611.

S. Adjustment of Existing Backflow Preventers

Adjustment of existing backflow preventers to grade in their original locations shall be measured on an individual basis on the number of each acceptably adjusted in accordance with Section 611.

T. Removal of Water Meters, Fire Hydrant Assemblies, and Backflow Preventers

Removal of existing water meters and boxes, fire hydrants assemblies, and backflow preventers shall be measured on an individual basis on the number of each removed.

U. Adjustment of Water Service Lines

Adjustment of water service lines shall be measured in linear feet (meters) of service line pipe lowered or raised, and shall include the length of valves, fittings, meters, boxes, and other appurtenances. Measurements are made from end to end of actual adjustments.

V. Concrete Thrust Blocks

Concrete thrust blocking installed shall be measured as indicated in Section 500 per cubic yard of concrete acceptably installed. When Concrete Thrust Blocks is not shown as a pay item, include the cost of the work in the bid price for the appropriate item.

W. Concrete Thrust Collars

Concrete thrust collars shall be measured on an individual basis on the number of each size thrust collar acceptably installed. When Concrete Thrust Collars is not shown as a pay item, include the cost of the work in the bid price for the appropriate item

X. Cut and Cap Water Main

Cutting and capping of water mains shall be measured on an individual basis per each instance of cutting and plugging existing mains as shown on the Plans.

Y. Removal of Water Mains

Unless specified removal of water mains shall be removed in accordance with Section 210. If specified removal of water mains shall be measured per linear foot for each size pipe actually removed in accordance with Section 610. Measurement shall be horizontally above the centerline of the pipe removed and shall include the length of valves and fittings.

Z. Line Stop

Line stops shall be measured on an individual basis on the number of each size line stop actually installed.

AA. Flowable Fill

Flowable fill shall be measured as indicted in Section 600 per cubic yard of flowable fill acceptably installed. When flowable fill is not shown as a pay item, include the cost of the work in the bid price for the appropriate item.

BB. Insertion Valve

Insertion valves shall be measured on an individual basis on the number of each size valve acceptably installed.

CC. Three-Dimensional (3D) Survey

Three-dimensional survey shall be measured as one lump sum for a complete and accepted survey. This item will be included in the overall pipe measurement. No separate payment for this work.

670.4.01 Limits

General Provisions 101 through 150.

670.5 Payment

The Contract Unit Price for each Item, complete and accepted, shall include all costs incidental to the construction of the Item according to the Plans and as specified in this Section. The unit prices bid shall include due allowance for the salvage value of all materials removed from existing or temporary lines and not installed in the completed work. All such surplus items shall become the property of the Contractor unless such surplus items are specified to be salvaged. Payment for any Item listed below is full compensation for the Item or Items complete in place.

A. Ductile Iron Water Mains

Ductile iron mains shall be paid for at the unit price per linear foot for each diameter pipe installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of pipe, joints and jointing materials, anchoring, warning tape, polyethylene encasement, protection of existing utilities, connections to existing water mains, sampling taps, temporary blow-offs, flushing, cleaning, pigging, chlorine for disinfection, disinfection, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration and all work and materials necessary to place the pipe into service.

B. PVC Water Main

PVC water mains shall be paid for at the unit price per linear foot for each diameter pipe installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of pipe, anchoring, tracer wire, warning tape, protection of existing utilities, connections to existing water mains, sampling taps, temporary blow-offs, flushing, cleaning, pigging, chlorine for disinfection, disinfection, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to place the pipe into service.

C. Fusible PVC Water Main

Fusible PVC water mains shall be paid for at the unit price per linear foot for each diameter pipe installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, entry/exit pits, installation of pipe, joints and jointing materials, tracer wire, warning tape, mechanical joint adapters, protection of existing utilities, connections to existing water mains, fusion process materials and equipment, directional drilling materials and equipment, tracking system, assembling, welding, supporting, stringing, pulling, pigging, cleaning, sampling taps, temporary blow-offs, flushing, chlorine for disinfection, disinfection, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, and restoration, and all incidentals necessary to place the pipe into service except where such items are shown to be paid for under a separate Pay Item.

D. HDPE Water Main

HDPE water mains shall be paid for at the unit price per linear foot for each diameter pipe installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, entry/exit pits, installation of pipe, tracer wire, warning tape, mechanical joint adapters, protection of existing utilities, connections to existing water mains, fusion process materials and equipment, directional drilling materials and equipment, tracking system, assembling, welding, supporting, stringing, pulling, pigging, cleaning, sampling taps, temporary blow-offs, flushing, chlorine for disinfection, disinfection, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, and restoration, and all incidentals necessary to place the pipe into service except where such items are shown to be paid for under a separate Pay Item.

E. Ductile Iron Fittings

Ductile iron fittings are considered subsidiary to the water line in which they are used and are not measured for separate payment as outlined in the manufacturers' catalogues and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of fittings, joints and jointing materials, anchoring, warning tape, polyethylene encasement, protection of existing utilities, flushing, chlorine for disinfection, disinfection, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, all other related and necessary materials, work and equipment required to install a complete and operable pipeline fitting. This Item includes, but is not limited to, wyes, tees, bends, crosses, sleeves, plugs and caps, couplings, and reducers.

F. Restrained Joints

Restrained joints are considered subsidiary to the water line in which they are used and are not measured for separate payment as outlined in the manufacturers' catalogues and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting, shoring, installation of the restraint device, polyethylene encasement, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to install the restrained joint.

G. Gate Valves

Gate valves shall be paid for at the unit price per each size gate valve and box assembly installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of the gate valves (including valve box), concrete pad or collar, valve identification disc, valve marker, valve tag, polyethylene encasement, protection of existing utilities, chlorine for disinfection, disinfection, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to install the gate valve and place it in service.

H. Butterfly Valves

Butterfly valves shall be paid for at the unit price per each size butterfly valve and box assembly installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of the butterfly valves including valve box, concrete pad or collar, valve identification disc, valve marker, valve tag, polyethylene encasement, protection of existing utilities, chlorine for disinfection, disinfection, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration and all work and materials necessary to install the butterfly valve and place it in service.

I. Tapping Sleeve and Valve Assembly

Tapping sleeve and valves assemblies shall be paid for at the unit price per each size tapping sleeve and valve assembly installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of tapping sleeves and valve assemblies including valve box, concrete pad or collar, valve marker, valve tag, polyethylene encasement, protection of existing utilities, tapping the potable water main, chlorine for disinfection, disinfection, sampling points, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and necessary hardware to install the tapping sleeve assembly and valve and place it in service.

J. Fire Hydrant Assembly

Fire hydrant assemblies shall be paid for at the unit price per each hydrant installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of the fire hydrant assemblies (all configurations), vertical extensions, tapping sleeve, valve, hydrant lead piping, joint connections, fittings, tees, restraints, crushed stone drain, polyethylene encasement, protection of existing utilities, valve box, concrete pad or collar, valve identification disc, valve marker, valve tag, chlorine for disinfection, disinfection, backfilling, backfill

material, disposal of unsuitable backfill materials, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to install the fire hydrant assembly and place it in service.

K. Water Service Line

Water service lines shall be paid for at the unit price per linear feet (meters) of the size service line installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of water service line, tracer wire, tapping saddle, sleeve, corporation stops, fittings, curb stops, casing pipe, plugging abandoned water service connection, removal of abandoned water service line, protection of existing utilities, locating and connection to existing or new water main, chlorine for disinfection, disinfection, sampling points, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to place the water service line into service. Water meter and box shall be paid for under a separate Pay Item.

L. Water Meter and Box

Water meters shall be paid for at the unit price per each size water meter installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of the meter and box, adjustment to final grade, fittings, protection of existing utilities, chlorine for disinfection, disinfection, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to place the meter into service except where such items are to be paid for under a separate Pay Item.

M. Backflow Preventer

Back flow prevention devices shall be paid for at the unit price per each type backflow preventer installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of the backflow preventer, concrete vault, adjustment to final grade, testing and certification, fittings, tees, restraints, protection of existing utilities, chlorine for disinfection, disinfection, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to place the meter into service except where such items are to be paid for under a separate Pay Item.

N. Air Release Valve Assembly

Air release valve assemblies shall be paid for at the unit price per each size and type of air release valve assembly installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of the air release assembly, tapping saddle, isolation valve, reducers, piping, restraints, fittings, tracer wire, concrete manhole or vault, ring and cover, protection of existing utilities, chlorine for disinfection, disinfection, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to place the air release assembly into service.

O. Pressure Reducing / Sustaining Valve

Pressure reducing / sustaining valve shall be paid for at the unit price per each size and type of pressure reducing / sustaining valve installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of the pressure reducing / sustaining valve, reducers, piping, restraints, fittings, tracer wire, concrete manhole or vault, ring and cover, tracer wire, protection of existing utilities, chlorine for disinfection, disinfection, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to place the pressure reducing / sustaining valve into service.

P. Blow-Off Assembly

Blow-off assemblies shall be paid for at the unit price per each blow-off assembly installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of the blow-off assembly, valves, valve boxes, concrete pad or collar, piping, restraints, fittings, tracer wire, protection of existing utilities, chlorine for disinfection, disinfection, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to place the blow-off assembly into service.

Q. Steel Casing

Steel casing pipe shall be paid for at the unit price per linear foot according to the diameter and thickness of the steel casing installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, protection of existing utilities, steel casing pipe, skid, steel straps, coatings, casing spacers, end seals, boring and jacking pits, backfilling, backfill materials, disposal of unsuitable backfill material, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to install the steel casing except where such items are shown to be paid for under a separate Item. The carrier pipe shall be paid from other applicable Pay Item.

R. Relocation of Existing Air Release Valve

Relocation of air release valves shall be paid for at the unit price per each air release valve assembly relocated and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheet and shoring, removal of existing air release valve assembly, installation at another location, piping, restraints, tracer wire, fittings, adjustment to final grade, polyethylene encasement, protection of existing utilities, chlorine for disinfection, disinfection backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration and all work necessary to locate, remove and relocate the air release valve except where such items are shown to be paid for under a separate Pay Item.

S. Relocation of Existing Fire Hydrant Assembly

Relocation of fire hydrants shall be paid for at the unit price per each hydrant assembly relocated and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheet and shoring, removal of existing fire hydrant assembly, installation at another location, vertical extensions, hydrant lead piping, joint connections, fittings, tees, restraints, crushed stone drain, polyethylene encasement, valve box, concrete pad or collar, valve identification disc, valve marker, adjustment to final grade, protection of existing utilities, chlorine for disinfection, disinfection, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work necessary to locate, remove and relocate the hydrant.

T. Relocation of Existing Backflow Prevention Devices

Relocation of backflow prevention devices shall be paid for at the unit price per each backflow preventer relocated and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheet and shoring, removal of existing backflow preventer, installation at another location, adjustment to final grade, testing and certification, fittings, tees, restraints, protection of existing utilities, chlorine for disinfection, disinfection, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work necessary to locate, remove and relocate the backflow prevention device. The service line from the main to the relocated backflow preventer shall be paid for under a separate Pay Item.

U. Relocation of Water Meter and Box

Relocation of existing water meter and boxes shall be paid for at the unit price of each water meter and box relocated and shall cover the cost of all materials, transportation, labor, equipment, excavation, sheeting and shoring, removal of existing water meter and box, installation at another location, adjustment to final grade, protection of existing utilities, chlorine for disinfection, disinfection, backfilling, backfill material, disposal of unsuitable backfill materials, tamping,

testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to relocate the water meter and box except where such items are shown to be paid for under a separate Item. The new service line from the main to the relocated meter shall be paid for under a separate Pay Item.

V. Adjustment of Existing Water Service Line

Adjustment of existing water service lines shall be paid in accordance with Section 611, for at the unit price per linear foot of service line adjusted and shall cover the cost of all materials, transportation, labor, equipment, excavation, sheeting and shoring, adjustment of service line, tracer wire and splices, chlorine for disinfection, disinfection, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to adjust the service line except where such items are shown to be paid for under a separate Pay Item.

W. Adjustment of Existing Water Valve Boxes to Grade

Adjustment of existing valve boxes shall be paid for in accordance with Section 611, at the unit price per each valve box adjusted to final grade and shall cover the cost of all materials, transportation, labor, equipment, excavation, sheeting and shoring, valve case and lid, trench adapter and operating nut extensions/reductions, tracer wire and splices, tracer wire riser and threaded plug, concrete pad, valve identification disc, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to adjust the valve box.

X. Adjustment of Blow-off Assembly

Adjustment of existing blow-off assemblies shall be paid for at the unit price per each blow-off adjusted to final grade and shall cover the cost of all materials, transportation, labor, equipment, excavation, sheeting and shoring, valve case and lid, trench adapter and operating nut extensions/reductions, tracer wire and splices, tracer wire riser and threaded plug, piping, concrete pad or collar, valve identification disc, chlorine for disinfection, disinfection, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to adjust the blow-off assembly.

Y. Adjustment of Existing Water Meter Boxes to Grade

Adjustment of existing meter boxes shall be paid for at the unit price per each meter box adjusted to finished grade and shall cover the cost of all materials, transportation, labor, equipment, excavation, sheeting and shoring, adjustment of water meter box to final grade, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to adjust the water meter box.

Z. Adjustment of Backflow Preventer

Adjustment of existing backflow preventers shall be paid for at the unit price per each backflow preventer adjusted to finished grade and shall cover the cost of all materials, transportation, labor, equipment, excavation, sheeting and shoring, adjustment of backflow preventer to final grade, adjustment of backflow preventer vault to final grade, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to adjust the water meter box.

AA. Adjustment of Existing Fire Hydrant Assembly to Grade

Adjustment of existing fire hydrants shall be paid for at the unit price per each hydrant adjusted to finished grade and shall cover the cost of all materials, transportation, labor, equipment, excavation, sheeting and shoring, adjustment of hydrant, protection of existing utilities, chlorine for disinfection, disinfection, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to adjust the hydrant.

BB. Removal of Water Valve and Box

Removal of water valves shall be paid for at the unit price per each valve removed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheet and shoring, removal of existing water valve and box, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, storage and delivery of removed valves identified to be salvaged, and all work necessary to remove the valve and box.

CC. Removal of Water Meter and Box

Removal of water meters shall be paid for at the unit price per each meter removed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheet and shoring, removal of existing water meter and box, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, storage and delivery of removed meters and boxes identified to be salvaged, and all work necessary to remove the meter.

DD. Removal of Fire Hydrant Assembly

Removal of fire hydrant assemblies shall be paid for at the unit price per each hydrant assembly removed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheet and shoring, removal of existing fire hydrant assembly, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, storage and delivery of removed hydrants identified to be salvaged, and all work necessary to remove the hydrant.

EE. Removal of Air Release Valve

Removal of air release valves shall be paid for at the unit price per each air release valve removed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, removal of air release valve assemblies, piping, concrete manholes or vaults, and fabricated enclosures, backfilling, backfill materials, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, storage and delivery of air release valves identified to be salvaged, and all work necessary to remove the air release valve.

FF. Removal of Backflow Prevention Devices

Removal of backflow prevention devices shall be paid for at the unit price per each backflow preventer removed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheet and shoring, removal of existing backflow preventer and vault, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, storage and delivery of removed backflow preventers identified to be salvaged, and all work necessary to remove the backflow preventers.

GG. Concrete Thrust Blocks

Concrete thrust blocks shall be paid for at the unit price per cubic yard of concrete complete in place as indicated in Section 500 and shall cover the cost of all materials, transportation, labor, equipment, excavation, sheeting and shoring, concrete, forming, reinforcement, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to install a complete thrust block. When Concrete Thrust Blocks is not shown as a pay item, include the cost of the work in the bid price for the appropriate item

HH. Concrete Thrust Collars

Concrete thrust collars shall be paid for at the unit price per each size of thrust collar and shall cover the cost of all materials, transportation, labor, equipment, excavation, sheeting and shoring**,** reinforced concrete thrust collars, retainer glands, reinforcement, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work and materials

necessary to install a complete thrust collar. When Concrete Thrust Collar is not shown as a pay item, include the cost of the work in the bid price for the appropriate item

II. Removal of Water Main

Removal of water mains shall be paid for at the unit price per linear foot of the size of water main to be removed in accordance with Section 610 and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, bypass pumping (as required), restoration, and all work and materials necessary to locate, remove and dispose of the pipe and associated appurtenances. Unless indicated for removal in a separate Pay Item, appurtenances to be removed shall include but not be limited to fittings, isolation valves, air release valves, valve boxes, blow-offs, steel casings, casing spacers, fire hydrant assemblies, water service lines, water meter boxes, thrust blocks, and concrete. All such surplus items shall become the property of the Contractor unless specified to be salvaged by the Utility Owner.

JJ. Cut and Plug Existing Water Main

Cutting and plugging of existing water mains shall be paid for at the unit price per each installation and shall cover all materials, transportation, labor, equipment, excavation, sheeting and shoring, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to cut and plug existing water mains, except where such items are shown to be paid for under a separate Pay Item.

KK. Line Stops

Line stops shall be paid for at the unit price per each size line stop installed and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of the line stop assemblies, valves, valve boxes, fittings, restraints, protection of existing utilities, chlorine for disinfection, disinfection, sampling points, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to install the gate valve and place it in service.

LL. Flowable Fill

Flowable fill shall be paid for at the unit price per cubic yard of flowable fill complete in place as indicated in Section 600 and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, flushing, plugging air release valves and service connections, installation of flowable fill, protection of existing utilities, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, utility crossings, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to install the gate valve and place it in service. When flowable fill is not shown as a pay item, include the cost of the work in the bid price for the appropriate item

MM. Insertion Valve

Insertion valves shall be paid for at the unit price per each size valve inserted and shall cover the cost for all materials, transportation, labor, equipment, excavation, sheeting and shoring, installation of the valve, valve boxes, fittings, restraints, concrete pad or collar, valve identification disc, valve marker, polyethylene encasement**,** protection of existing utilities, chlorine for disinfection, disinfection, sampling points, backfilling, backfill material, disposal of unsuitable backfill materials, tamping, testing, densities, dewatering, trench stabilization, clean-up, restoration, and all work and materials necessary to install the insertion valve and place it in service.

NN. Three-Dimensional (3D) Survey

Three-dimensional survey cost will be included in the overall pipe measurement and no separate payment for this work will be made, and it shall cover the costs for all non-destructive methods of locating installed utilities and associated electronic deliverables per Utility Owner specifications.

Payment will be made under:

Item No. 670	Water Main_____ in (mm)	Per linear foot (meter)
Item No. 670	Gate Valve_____ in (mm)	Per each
Item No. 670	Tapping Sleeve and Valve Assembly __ in (mm) x____ in (mm)	Per each
Item No. 670	Fire Hydrant	Per each
Item No. 670	Water Service Line_____ in (mm)	Per linear foot (meter)
Item No. 670	Relocate Existing Fire Hydrant	Per each
Item No. 670	Relocate Existing Water Valve including Box	Per each
Item No. 670	Relocate Existing Water Meter including Box	Per each
Item No. 670	Adjust Water Service Line to Grade	Per linear foot (meter)
Item No. 670	Remove Existing Water Meter including Box	Per each
Item No. 670	Remove existing fire hydrant	Per each
Item No. 670	Steel casing_____ in (mm)	Per linear foot (meter)
Item No. 670	Butterfly valve_____ in (mm)	Per each
Item No. 670	Double strap saddle_____ in (mm) x_____ in (mm)	Per each

Item No. 670	Tapping Valve, ___ in(mm)	Per each
Item No. 670	Air Release Valve Assembly_____ in (mm)	Per each
Item No. 670	Water Meter, ___ in	Per each
Item No. 670	Insertion Valve, ____in	Per each
Item No. 670	Line Stop_____ in (mm)	Per each
Item No. 670	Cut and Plug Existing Water Main	Per each
Item No. 670	Blow-Off Assembly, Complete	Per each
Item No. 670	Pressure Reducing/Sustaining Valve	Per each
Item No. 670	Backflow Prevention Assembly	Per each
Item No. 670	Concrete Thrust Collar, _____ in	Per each
Item No. 670	Relocate Backflow Prevention Assembly	Per each
Item No. 670	Relocate Existing Water Meter, including Bypass & Vault_____ in (mm)	Per each
Item No. 670	Relocate Pressure Reducing/Sustaining Valve	Per each
Item No. 670	Adjust Blowoff Assembly	Per each
Item No. 670	Remove Existing Water Valve, including Box	Per each
Item No. 670	Remove Existing Fire Hydrant	Per each

670.5.01 Adjustments

General Provisions 101 through 150.

APPENDIX A

FULTON COUNTY

WATER RESOURCES DEPARTMENT

TECHNICAL SPECIFICATION FOR WATER MAIN CONSTRUCTION

FULTON COUNTY

FULTON COUNTY
WATER RESOURCES DEPARTMENT
TECHNICAL SPECIFICATION FOR WATER MAIN CONSTRUCTION

Part 1 General

1.01 Scope

A. The work under this Section consists of furnishing all labor, equipment and materials and performing all operations in connection with the trench excavation and backfill required to install the water lines as shown on the Drawings and as specified.

B. Excavation shall include the removal of any trees, stumps, brush, debris or other obstacles which remain after the clearing and grubbing operations, which may obstruct the work, and the excavation and removal of all earth, rock or other materials to the extent necessary to install the pipeline and appurtenances in conformance with the lines and grades shown on the Drawings and as specified.

C. Backfill shall include the refilling and compaction of the fill in the trenches and excavations up to the surrounding ground surface or road grade at crossing.

D. The trench is divided into five specific areas:

1. Foundation: The area beneath the bedding, sometimes also referenced to as trench stabilization.

2. Bedding: The area above the trench bottom (or foundation) and below the bottom of the barrel of the pipe.

3. Haunching: The area above the bottom of the barrel of the pipe up to a specified height above the bottom of the barrel of the pipe.

4. Initial Backfill: The area above the haunching material and below a plane 18 inches above the top of the barrel of the pipe.

5. Final Backfill: The area above a plane 18-inches above the top of the barrel of the pipe.

E. The choice of method, means, techniques and equipment rests with the Contractor. The Contractor shall select the method and equipment for trench excavation and backfill depending upon the type of material to be excavated and backfilled, the depth of excavation, the amount of space available for operation of equipment, storage of excavated material, proximity of man-made improvements to be protected, available easement or right-of-way and prevailing practice in the area.

1.02 Quality Assurance

A. Density: All references to “maximum dry density” shall mean the maximum dry density defined by the “Maximum Density-Optimum Moisture Test”, ASTM D 698, except that for non-cohesive materials “maximum dry density” shall mean the maximum index density as determined by the “Maximum Index Density of Soils Using a Vibratory Table”, ASTM D 4253. Determination of the density of foundation, bedding, haunching, or backfill materials in place shall meet with the requirements of ASTM D 1556, “Density of Soil In Place by the Sand Cone Method”, ASTM D 2937, “Density of Soil In Place by the Drive-Cylinder Method”

or ASTM D 2922, "Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)".

B. Sources and Evaluation Testing: Testing of materials to certify conformance with the Specifications shall be performed by an independent testing laboratory in accordance with Section 01410 of these Specifications. All imported fill materials shall meet the requirements of on-site fill materials.

1.03 Safety

Perform all trench excavation and backfilling activities in accordance with the Occupational Safety and Health Act of 1970 (PL 91-596), as amended. The Contractor shall pay particular attention to the Safety and Health Regulations Part 1926, Subpart P "Excavation, Trenching & Shoring" as described in OSHA publication 2226.

Part 2 Products

2.01 Trench Foundation Materials

A. Crushed stone shall be utilized for trench foundation (trench stabilization) and shall meet the requirements of the Georgia Department of Transportation Specification 800.2.01, Group I (limestone, marble or dolomite) or Group II (quartzite, granite or gneiss). Stone size shall be between No. 57 and No. 4, inclusive.

2.02 Bedding and Haunching Materials

A. Unless specified otherwise, bedding and haunching materials shall be crushed stone as specified below.

B. Crushed stone utilized for bedding and haunching shall meet the requirements of the Georgia Department of Transportation Specification 800.01, Group I (limestone, marble or dolomite) or Group II (quartzite, granite or gneiss). Stone size shall be between No. 57 and No. 4, inclusive.

C. Earth materials utilized for bedding and haunching shall be suitable materials selected from materials excavated from the trench. Suitable materials shall be clean and free of rock larger than 2-inches at its largest dimension, organics, cinders, stumps, limbs, frozen earth or mud, man-made wastes and other unsuitable materials. Should the material excavated from the trench be saturated, the saturated material may be used as earth material, provided it is allowed to dry properly and it is capable of meeting the specified compaction requirements. When necessary, earth bedding and haunching materials shall be moistened to facilitate compaction by tamping. If materials excavated from the trench are not suitable for use as bedding or haunching material, provide select material conforming to the requirements of this Section at no additional cost to the Owner.

D. Filter Fabric Woven Type

1. Filter fabric associated with bedding shall be a polypropylene woven fabric. The fabric shall be a high modulus type with good separation capabilities. The fabric shall be inert to biological degradation and naturally occurring chemicals, alkalies and acids.

2. The fabric shall have an equivalent opening size EOS of 20 to 45. The fabric shall also conform to the minimum property values listed in the following table:

Fabric Property	Unit	Test Method	Minimum Value
Grab Tensile Strength	lbs.	ASTM D 4632	200
Grab Tensile Elongation	%	ASTM D 4632	30 (max.)
Mullen Burst Strength	psi	ASTM D 3786	400
Trapezoid Tear Strength	lbs.	ASTM D 4533	75
Puncture Strength	lbs.	ASTM D 3787	75

3. If ordered by the Engineer, the filter fabric manufacturer shall furnish the services of a competent factory representative to supervise and/or inspect the installation of pipe. This service will be furnished for a minimum of 10 days during initial pipe installation.

4. Filter fabric shall be Mirafi 500X, Amoco 2002 or Exxon GTF-200.

2.03 Initial Backfill

A. Initial backfill material shall be crushed stone or earth materials as specified for bedding and haunching materials.

B. When necessary, initial backfill materials shall be moistened to facilitate compaction by tamping. If materials excavated from the trench are not suitable for use as initial backfill material, provide select material conforming to the requirements of this Section at no additional cost to the owner.

2.04 Final Backfill

A. Final backfill material shall be general excavated earth materials, shall not contain rock larger than 2-inches at its greatest diameter, cinders, stumps, limbs, man-made wastes and other unsuitable materials. If materials excavated from the trench are not suitable for use as final backfill material, provide select material conforming to the requirements of this Section.

2.05 Select Backfill

Select backfill shall be materials which meet the requirements as specified for bedding, haunching or initial backfill materials, including compaction requirements.

2.06 Concrete

A. Concrete for bedding, haunching, initial backfill or encasement shall have a compressive strength of not less than 3,000 psi, with not less than 5.5 bags of cement per cubic yard and a slump between 3 and 5-inches. Ready-mixed concrete shall be mixed and transported in accordance with ASTM C 94. Reinforcing steel shall conform to the requirements of ASTM A 615, Grade 60.

Part 3 Execution

3.01 Trench Excavation

A. Topsoil and grass shall be stripped a minimum of 6-inches over the trench excavation site and stockpiled separately for replacement over the finished grading areas.

B. Trenches shall be excavated to the lines and grades shown on the Drawings with the centerlines of the trenches on the centerlines of the pipes and to the dimensions which provide the proper support and protection of the pipe and other structures and accessories.

C. Trench Width for Pipelines

1. The sides of all trenches shall be vertical to a minimum of one foot above the top of the pipe. Unless otherwise indicated on the Drawings, the maximum trench width shall be equal to the sum of the outside diameter of the pipe plus two feet. The minimum trench width shall be that which allows the proper consolidation of the haunching and initial backfill material.

2. Excavate the top portion of the trench to any width within the construction easement or right-of-way which will not cause unnecessary damage to adjoining structures, roadways, pavement, utilities, trees or private property. Where necessary to accomplish this, provide sheeting and shoring.

3. Where rock is encountered in trenches, excavate to remove boulders and stones to provide a minimum of 9-inches clearance between the rock and any part of the pipe barrel or manhole.

4. Wherever the prescribed maximum trench width is exceeded, the Contractor shall use the next higher Class or Type of bedding and haunching as shown on the Drawings for the full trench width as actually cut. The excessive trench width may be due to unstable trench walls, inadequate or improperly placed bracing and sheeting which caused sloughing, accidental over-excavation, intentional over-excavation necessitated by the size of the Contractor's tamping and compaction equipment, intentional over-excavation due to the size of the Contractor's excavation equipment, or other reasons beyond the control of the Engineer or Owner.

D. Depth

1. The trenches shall be excavated to the required depth or elevation which allow for the placement of the pipe and bedding to the dimensions shown on the Drawings.

2. Where rock is encountered in trenches for pipelines, excavate to the minimum depth which will provide clearance below the pipe barrel of 8-inches for pipe 21-inches in diameter and smaller and 12-inches for larger pipe, valves and manholes.

E. Excavated Materials

1. Excavated materials shall be placed adjacent to the work to be used for backfilling as required. Top soil shall be carefully separated and lastly placed in its original location.

2. Excavated material shall be placed sufficiently back from the edge of the excavation to prevent caving of the trench wall, to permit safe access along the trench and not cause any drainage problems. Excavated material shall be placed so as not to damage existing landscape features or man-made improvements.

3.02 Sheeting, Bracing and Shoring

A. Sheeting, bracing and shoring shall be installed in the following instances:

1. Where sloping of the trench walls does not adequately protect persons within the trench from slides or cave-ins.

2. In caving ground.

3. In wet, saturated, flowing or otherwise unstable materials.

4. Where necessary to prevent damage to adjoining buildings, structures, roadways, pavement, utilities, trees or private properties which are required to remain.

5. Where necessary to maintain the top of the trench within the available construction easement or right-of-way.

B. In all cases, excavation protection shall strictly conform to the requirements of the Occupational Safety and Health Act of 1970, as amended.

C. Timber: Timber for shoring, sheeting, or bracing shall be sound and free of large or loose knots and in good, serviceable condition. Size and spacing shall be in accordance with OSHA regulations.

D. Steel Sheeting and Sheet Piling: Steel sheet piling shall be the continuous interlock type. The weight, depth and section modulus of the sheet piling shall be sufficient to restrain the loads of earth pressure and surcharge from existing foundations and live loads. Procedure for installation and bracing shall be so scheduled and coordinated with the removal of the earth that the ground under existing structures shall be protected against lateral movement at all times. The Contractor shall provide closure and sealing between sheet piling and existing facilities.

E. Trench Shield: A trench shield or box may be used to support the trench walls. The use of a trench shield does not necessarily preclude the additional use of bracing and sheeting. When trench shields are used, care must be taken to avoid disturbing the alignment and grade of the pipe or disrupting the haunching of the pipe as the shield is moved. When the bottom of the trench shield extends below the top of the pipe, the trench shield will be raised in 6-inch increments with specified backfilling occurring simultaneously. At no time shall the trench shield be “dragged” with the bottom of the shield extending below the top of the pipe or utility.

F. Remove bracing and sheeting in units when backfill reaches the point necessary to protect the pipe and adjacent property. Leave sheeting in place when in the

opinion of the Engineer it cannot be safely removed or is within three feet of an existing structure, utility, or pipeline. Cut off any sheeting left in place at least two feet below the surface.

G. Sheet piling within three feet of an existing structure or pipeline shall remain in place, unless otherwise directed by the Engineer.

3.03 Rock Excavation

A. Definition of Rock: Any material which cannot be excavated with conventional excavating equipment, and is removed by drilling and blasting, and occupies an original volume of at least one-half cubic yard.

B. Blasting: Provide licensed, experienced workmen to perform blasting. Conduct blasting operations in accordance with all existing ordinances and regulations. Protect all buildings and structures from the effects of the blast. Repair any resulting damage. If the Contractor repeatedly uses excessive blasting charges or blasts in an unsafe or improper manner, the Engineer may direct the Contractor to employ an independent blasting consultant to supervise the preparation for each blast and approve the quantity of each charge.

C. Removal of Rock: Dispose of rock off site that is surplus or not suitable for use as rip rap or backfill.

D. The Contractor shall notify the Engineer prior to any blasting. Additionally, the Contractor shall notify the Engineer and local fire department before any charge is set.

E. Following review by the Engineer regarding the proximity of permanent buildings and structures to the blasting site, the Engineer may direct the Contractor to employ an independent, qualified specialty sub- contractor, approved by the Engineer, to monitor the blasting by use of seismograph, identify the areas where light charges must be used, conduct pre-blast and post-blast inspections of structures, including photographs or videos, and maintain a detailed written log.

3.04 Dewatering Excavations

A. Dewater excavation continuously to maintain a water level two feet below the bottom of the trench.

B. Control drainage in the vicinity of excavation so the ground surface is properly pitched to prevent water running into the excavation.

C. There shall be sufficient pumping equipment, in good working order, available at all times, to remove any water that accumulates in excavations. Where the utility crosses natural drainage channels, the work shall be conducted in such a manner that unnecessary damage or delays in the prosecution of the work will be prevented. Provision shall be made for the satisfactory disposal of surface water to prevent damage to public or private property.

D. In all cases, accumulated water in the trench shall be removed before placing bedding or haunching, laying pipe, placing concrete or backfilling.

E. Where dewatering is performed by pumping the water from a sump, crushed stone shall be used as the medium for conducting the water to the sump. Sump depth shall be at least two feet below the bottom of the trench. Pumping

equipment shall be of sufficient quantity and/or capacity to maintain the water level in the sump two feet below the bottom of the trench. Pumps shall be a type such that intermittent flows can be discharged. A standby pump shall be required in the event the operating pump or pumps clog or otherwise stop operation.

F. Dewater by use of a well point system when pumping from sumps does not lower the water level two feet below the trench bottom. Where soil conditions dictate, the Contractor shall construct well points cased in sand wicks. The casing, 6 to 10-inches in diameter, shall be jetted into the ground, followed by the installation of the well point, filling casing with sand and withdrawing the casing.

3.05 Trench Foundation and Stabilization

A. The bottom of the trench shall provide a foundation to support the pipe and its specified bedding. The trench bottom shall be graded to support the pipe and bedding uniformly throughout its length and width.

B. If, after dewatering as specified above, the trench bottom is spongy, or if the trench bottom does not provide firm, stable footing and the material at the bottom of the trench will still not adequately support the pipe, the trench will be determined to be unsuitable and the Engineer shall then authorize payment for trench stabilization.

C. Should the undisturbed material encountered at the trench bottom constitute, in the opinion of the Engineer, an unstable foundation for the pipe, the Contractor shall be required to remove such unstable material and fill the trench to the proper subgrade with crushed stone as directed by the Engineer.

D. Where the replacement of unsuitable material with crushed stone does not provide an adequate trench foundation, the trench bottom shall be excavated to a depth of at least two feet below the specified trench bottom. Place filter fabric in the bottom of the trench and support the fabric along the trench walls until the trench stabilization, bedding, haunching and pipe have been placed at the proper grade. The ends of the filter fabric shall be overlapped by one foot above the pipe.

E. Where trench stabilization is provided, the trench stabilization material shall be compacted to at least 90 percent of the maximum dry density, unless shown or specified otherwise.

3.06 Bedding and Haunching

A. Prior to placement of bedding material, the trench bottom shall be free of any water, loose rocks, boulders or large dirt clods.

B. Bedding material shall be placed to provide uniform support along the bottom of the pipe and to place and maintain the pipe at the proper elevation. The initial layer of bedding placed to receive the pipe shall be brought to the grade and dimensions indicated on the Drawings. All bedding shall extend the full width of the trench bottom. The pipe shall be placed and brought to grade by tamping the bedding material or by removal of the excess amount of the bedding material under the pipe. Adjustment to grade line shall be made by scraping away or filling with bedding material. Wedging or blocking up of pipe shall not be permitted. Applying pressure to the top of the pipe, such as with a backhoe bucket, to lower the pipe to the proper elevation or grade shall not be permitted. Each pipe

section shall have a uniform bearing on the bedding for the length of the pipe, except immediately at the joint.

C. At each joint, excavate bell holes of ample depth and width to permit the joint to be assembled properly and to relieve the pipe bell of any load.

D. After the pipe section is properly placed, add the haunching material to the specified depth. The haunching material shall be shovel sliced, tamped, vigorously chinked or otherwise consolidated to provide uniform support for the pipe barrel and to fill completely the voids under the pipe, including the bell hole. Prior to placement of the haunching material, the bedding shall be clean and free of any water, loose rocks, boulders or dirt clods.

E. Water Mains

1. Ductile Iron Pipe

a. Unless otherwise shown on the Drawings or specified, utilize earth materials for bedding and haunching. Type 2, 3, 4 and 5 bedding shall be as detailed on the Drawings.

b. Unless specified or shown otherwise, bedding shall meet the requirements for Type 2 Pipe Bedding. Unless specified or shown otherwise for restrained joint pipe and fittings, bedding shall meet the requirements for Type 4 Pipe Bedding.

c. Where the depth of cover over the piping exceeds 9 feet, the pipe bedding shall meet the requirements of Type 4 Pipe Bedding. Where the depth of cover over the piping exceeds 14 feet, the pipe bedding shall meet the requirements of Type 5 Pipe Bedding.

d. Type 4 or Type 5 Pipe Bedding called for on the Drawings, specified or ordered by the Engineer, shall meet requirements for Type 4 or Type 5 Pipe Bedding, utilizing crushed stone bedding and haunching material.

F. Manholes: Excavate to a minimum of 12-inches below the planned elevation of the base of the manhole. Place and compact crushed stone bedding material to the required grade before installing the manhole.

G. Excessive Width and Depth

1. Water Mains: If the trench is excavated to excess width, provide the next higher type or class of pipe bedding, but a minimum of Type 4, as detailed on the Drawings.

2. If the trench is excavated to excessive depth, provide crushed stone to place the bedding at the proper elevation or grade.

H. Compaction: Bedding and haunching materials under pipe, manholes and accessories shall be compacted to a minimum of 90 percent of the maximum dry density, unless shown or specified otherwise.

3.07 Initial Backfill

A. Initial backfill shall be placed to anchor the pipe, protect the pipe from damage by subsequent backfill and ensure the uniform distribution of the loads over the top of the pipe.

B. Place initial backfill material carefully around the pipe in uniform layers to a depth of at least 18-inches above the pipe barrel or duct bank. Layer depths shall be a maximum of 6-inches for pipe 18-inches in diameter and smaller and a maximum of 12-inches for pipe larger than 18-inches in diameter.

C. Backfill on both sides of the pipe simultaneously to prevent side pressures.

D. Compact each layer thoroughly with suitable hand tools or tamping equipment.

E. Initial backfill shall be compacted to a minimum 90 percent of the maximum dry density, unless shown or specified otherwise.

F. If materials excavated from the trench are not suitable for use as backfill materials, provide select backfill material conforming to the requirements of this Section.

3.08 Concrete Encasement for Pipelines

Where concrete encasement is shown on the Drawings for pipelines, excavate the trench to provide a minimum of 6-inches clearance from the bell of the pipe. Lay the pipe to line and grade on concrete blocks. In lieu of bedding, haunching and initial backfill, place concrete to the full width of the trench and to a height of not less than 12-inches above the pipe bell. Do not backfill the trench for a period of at least 24 hours after concrete is placed.

3.09 Final Backfill

A. Backfill carefully to restore the ground surface to its original condition.

B. The top 6-inches shall be topsoil obtained as specified in “Trench Excavation” of this Section.

C. Excavated material which is unsuitable for backfilling, and excess material, shall be disposed of, at no additional cost to the Owner, in a manner approved by the Engineer. Surplus soil may be neatly distributed and spread over the site, if approved by the Engineer. If such spreading is allowed, the site shall be left in a clean and sightly condition and shall not affect pre-construction drainage patterns. Surplus rock from the trenching operations shall be removed from the site.

D. If materials excavated from the trench are not suitable for use as backfill materials, provide select backfill material conforming to the requirements of this Section.

E. After initial backfill material has been placed and compacted, backfill with final backfill material. Place backfill material in uniform layers, compacting each layer thoroughly as follows:

1. In 6-inch layers, if using light power tamping equipment, such as a “jumping jack”.

2. In 12-inch layers, if using heavy tamping equipment, such as hammer with tamping feet.

3. In 24-inch layers, if using a hydra-hammer.

F. Settlement: If trench settles, re-fill and grade the surface to conform to the adjacent surfaces.

G. Final backfill shall be compacted to a minimum 90 percent of the maximum dry density, unless specified otherwise.

3.10 Additional Material

Where final grades above the pre-construction grades are required to maintain minimum cover, additional fill material will be as shown on the Drawings. Utilize excess material excavated from the trench, if the material is suitable. If excess excavated materials are not suitable, or if the quantity available is not sufficient, provide additional suitable fill material at no cost to the owner.

3.11 Backfill Under Roads

Compact backfill underlying pavement and sidewalks, and backfill under dirt and gravel roads to a minimum 95 percent of the maximum dry density. The top 12-inches shall be compacted to a minimum of 98 percent of the maximum dry density.

3.12 Backfill Within Georgia DOT Right-of-Way

Backfill within the Georgia DOT right-of-way shall meet the requirements stipulated in the “Utility Accommodation Policy and Standards”, published by the Georgia Department of Transportation.

3.13 Backfill Along Restrained Joint Pipe

Backfill along restrained joint pipe shall be compacted to a minimum 90 percent of the maximum dry density.

3.14 Testing and Inspection

A. The soils testing laboratory is responsible for the following:

1. Compaction tests in accordance with Article 1.02 of this Section.

2. Field density tests for each two feet of lift, one test for each 500 feet of pipe installed or more frequently if ordered by the Engineer.

3. Inspecting and testing stripped site, subgrades and proposed fill materials.

B. The Contractor's duties relative to testing include:

1. Notifying laboratory of conditions requiring testing.

2. Coordinating with laboratory for field testing.

3. Paying costs for additional testing performed beyond the scope of that required and for re-testing where initial tests reveal non-conformance with specified requirements.

4. Providing excavation as necessary for laboratory personnel to conduct tests.

C. Inspection

1. Earthwork operations, acceptability of excavated materials for bedding or backfill, and placing and compaction of bedding and backfill is subject to inspection by the Engineer.

D. Comply with applicable codes, ordinances, rules, regulations and laws of local, municipal, state or federal authorities having jurisdiction.

END OF SECTION

Part 1 General

1.01 Scope

A. The work covered by this Section includes furnishing all labor, materials and equipment required to bore and jack casings and to properly complete pipeline construction as described herein and/or shown on the Drawings.

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

1.02 Submittals

A. Submit shop drawings, product data and experience in accordance with the requirements of Section 01340 of these Specifications.

B. Material Submittals: The Contractor shall provide shop drawings and other pertinent specifications and product data as follows:

1. Shop drawings for casing pipe showing sizes and connection details.

2. Design mixes for concrete and grout.

C. Experience Submittals

1. Boring and jacking casings is deemed to be specialty contractor work. If the Contractor elects to perform the work, the Contractor shall provide evidence as required by the General Conditions. A minimum of five continuous years of experience in steel casing construction is required of the casing installer. Evidence of this experience must be provided with the shop drawings for review by the Engineer.

1.03 Storage and Protection

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

Part 2 Products

2.01 Materials and Construction

A. Casing

1. The casing shall be new and unused pipe. The casing shall be made from steel plate having minimum yield strength of 35,000 psi. The steel plate shall also meet the chemical requirements of one of the following: ASTM A36; ASTM A139, Grade B, C, D or E; ASTM A53, Type S or Type E, Grade A or B.

2. The thicknesses of casing shown in paragraph B. below are minimum thicknesses. Actual thicknesses shall be determined by the casing installer, based on an 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 at no additional cost to the Owner.

3. The diameters of casing shown in paragraph B. below and shown on the Drawings are the minimum required. Larger casings, with the Engineer's approval, may be provided at no additional cost to the Owner, for whatever reasons the Contractor may decide, whether casing size availability, line and grade tolerances, soil conditions, etc.

B. Casing Sizes

UNDER HIGHWAYS/ROADWAYS		
Pipe Diameter, inches	Casing Diameter, inches	Wall Thickness, inches
12	18	0.350
42	60	0.500
54	72	0.531

C. Carrier Pipe: Carrier pipes shall meet requirements as specified in Section 02665 of these Specifications. All water pipe shall be ductile iron pipe.

D. Surface Settlement Markers: Surface settlement markers within pavement areas shall be P.K. nails. Surface settlement markers within non-paved areas shall be wooden hubs.

E. Grout and Cover Materials

1. Soil backfill for trench approaches and pits to finish grade shall be type as specified in Section 02225.

2. Fill and seal group at pipe ends using one of the following methods:

   a. Brick and mortar with type I or Type II cement conforming to ASTM C150, clean fresh water, sand conforming to ASTM C404, size No. 1. Grout shall have a minimum compressive strength of 1,000 psi, attained within 24 hours.

   b. End seals constructed of 1/8" thick neoprene rubber with ½' think T304 stainless steel bandings and 100% non-magnetic worm gear mechanisms. Casing end seals shall be Advance Products & Systems, Inc. Model AW.

3. Cement grout mix shall be one part Portland cement, and 6 parts mortar sand mixed with fresh, clean water to consistency applicable grouting.

   a. Mortar sand shall meet the requirements of ASTM C404, size no. 1.

b. Portland cement shall meet the requirements of ASTM C1560, Type I or II.

F. Casing spacers: Casing spacers shall be a two-piece shell fabricated from T-304 stainless steel of a minimum 14 gauge thickness. Each shell section shall be lined with a 0.090-inch thick, ribbed PVC extrusion with a retaining section overlapping the edges of the shell. Bearing surfaces (runners) shall be attached to support sections at positions to properly support the carrier pipe with the casing. The runners shall be mechanically bolted to the riser. Risers shall be made of T-304 stainless steel of a maximum 10 gauge. All risers shall be welded to the shell. Casing spacers shall be manufactured by Cascade Waterworks Manufacturing Company.

2.02 Equipment

A. A cutting head shall be attached to a continuous auger mounted inside the casing pipe.

B. The steering head shall be controlled manually from the bore pit. The grade indicator shall consist of a water level attached to the casing which would indicate the elevation of the front end of the casing or some other means for grade indication approved by the Engineer.

Part 3 Execution

3.01 General

A. Interpretation of soil investigation reports and data, investigating the site and determination of the site soil conditions prior to bidding is the sole responsibility of the Contractor. Any subsurface investigation by the Bidder or Contractor must be approved by the appropriate authority having jurisdiction over the site. Rock and/or water, if encountered, shall not entitle the Contractor to additional compensation.

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

C. The Contractor shall locate, identify, and protect utilities indicated to remain from damage. Utility companies shall be notified to locate existing utilities.

D. Plant life, lawns, and other features remaining as portion of final landscaping shall be protected during the execution of work.

E. The Contractor shall protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

F. The Contractor shall notify the Engineer in the event of utility conflicts and when minimum separation from existing utilities is not possible.

G. Face Protection: The face of the excavation shall be protected from the collapse of the soil into the casing.

H. Casing Design: Design of the bore pit and required bearing to resist jacking forces is the responsibility of the Contractor. The excavation method selected shall be compatible with expected ground conditions. The lengths of the casing shown on the Drawings are the minimum lengths required. The length of the casing may be extended for the convenience of the Contractor, at no additional cost to the Owner. Due to restrictive right-of-way and construction easements, boring and jacking casing lengths less than the nominal 20 foot length may be necessary.

I. Roadway Crossings

1. The Contractor shall be held responsible and accountable for the coordinating and scheduling of all construction work within the roadway right-of-way.

2. Work along or across the roadway department rights-of-way shall be subject to inspection by GDOT, Fulton County and/or the City of Alpharetta.

3. All installations shall be performed to leave free flows in drainage ditches, pipes, culverts or other surface drainage facilities of the roadway, street or its connections.

4. No excavated material or equipment shall be placed on the pavement or shoulders of the roadway without the express approval of the Engineer and the City of Alpharetta roadway department.

5. In no instance will the Contractor be permitted to leave equipment (trucks, backhoes, etc.) on the pavement or shoulder overnight. Construction materials to be installed, which are placed on the right-of-way in advance of construction, shall be placed in such a manner as not to interfere with the safe operation of the roadway.

6. The Contractor shall be responsible for providing the Owner sufficient information to obtain a blasting permit in a timely manner.

3.02 Groundwater Control

A. The Contractor shall control the groundwater throughout the construction of the casing.

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 Engineer 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. Dewatering shall be performed in such a manner that removal of soil particles is held to a minimum. Dewater into a sediment trap and comply with requirements specified in Section 02125 of these Specifications.

3.03 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 roadbed 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 roadbed.

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”.

3.04 Surface Settlement Monitoring

A. Provide surface settlement markers, placed as specified and as directed by the Engineer. The Contractor shall place settlement markers outside of pavement area, along the centerline of the casing at 10 foot intervals and offset 10 feet each way from the centerline. Markers shall also be placed 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 casing. Tie settlement markers to bench marks and indices sufficiently removed as not to be affected by the casing operations.

B. Make observations of surface settlement markers, placed as required herein, at regular time intervals acceptable to the Engineer. In the event settlement or heave on any marker exceeds 1-inch, the Contractor shall immediately cease work and using a method approved by the Engineer 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. The following schedule shall be used 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 Engineer's direction if settlement is identified. Make all elevation measurements to the nearest 0.01 foot.

D. The Contractor shall 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 Engineer and take immediate remedial action.

3.05 Boring and Jacking

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 directed by the Engineer 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. Boring and jacking of casing pipes shall be accomplished by the dry auger boring method without jetting, sluicing or wetboring.

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. 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.

G. As the casing is installed, check the horizontal and vertical alignment frequently. Make corrections prior to continuing operation. For casing pipe installations over 100 feet in length, the auger shall be removed and the alignment and grade checked at minimum intervals of 60 feet.

H. Any casing pipe damaged in jacking operations shall be repaired, if approved by the Engineer, 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. The Contractor shall maintain and operate pumps and other necessary drainage system equipment to keep work dewatered at all times.

N. 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, the sheeting, shoring and bracing shall be left in place, cut off or removed, as designated by the Engineer.

O. Trench excavation, all classes and type of excavation, the removal of rock, muck, debris, the excavation of all working pits and backfill requirements of Section 02225 are included under this Section.

P. All surplus material shall be removed from the right-of-way and the excavation finished flush with the surrounding ground.

Q. Grout backfill shall be used for unused holes or abandoned pipes.

3.06 Free Boring

A. Where the Drawings or Specifications indicate a pipeline or service connection is to be installed by boring without casing or where ordered by the Engineer, the Contractor shall install the pipe by the free bore method. The allowed free bore method will be dry auger boring, 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. The Contractor shall be responsible for any settlement of the surface (roadway, driveway, or otherwise) caused by the free bore construction activities.

D. Where the Drawings or Specifications indicate a free bore or where ordered to use the free bore method to install a segment of pipe, the Contractor may elect to install the pipe by the conventional bore and jack casing method instead.

E. If the Contractor elects to free bore, and an acceptable installation does not result for any reason, the Contractor shall install a casing pipe by the bore and jack method at no additional cost to the Owner.

F. The Contractor may elect to free bore other portions of the project in lieu of open cut installation. However, no additional payment for free bore will be made if the Contractor exercises this option.

3.07 Rock Excavation

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

B. At the Contractor's option, the Contractor may continue to install the casing and remove the rock through the casing at no additional cost to the Owner.

3.08 Installation of Carrier Pipe

A. After the casing pipe has been installed, the alignment and elevations shall be verified and submitted to the Engineer for approval, prior to the installation of the carrier pipe.

B. The carrier pipe shall be installed centered within the casing pipe, and shall be supported by casing spacers, centered on 10-foot intervals and as shown on the Drawings.

C. The Contractor shall exercise care to prevent damage to pipe joints when carrier pipe is placed in casing.

D. Support the pipeline within casing so no external loads are transmitted to carrier pipe. Attach supports to barrel of carrier pipe; do not rest carrier pipe on bells. A minimum clearance of 1-inch shall be maintained between the pipe bell and casing pipe.

E. The ends of the casing shall be sealed by either grouting or installing casing end seals.

3.09 Sheeting Removal

Remove sheeting used for shoring from the shaft and off the job site. The removal of sheeting, shoring and bracing shall be done in such a manner as not to endanger or damage either new or existing structures, private or public properties and also to avoid cave-ins or sliding in the banks.

END OF SECTION

Part 1 General

1.01 Scope

A. This Section describes products to be incorporated into the water mains and requirements for the installation and use of these items. Furnish all products and perform all labor necessary to fulfill the requirements of these Specifications.

B. Supply all products and perform all work in accordance with applicable American Society for Testing and Material (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), or other recognized standards. Latest revisions of all standards are applicable.

1.02 Qualifications

If requested by the Engineer, submit evidence that manufacturers have consistently produced products of satisfactory quality and performance for a period of at least two years.

1.03 Submittals

A. Complete shop drawings, product data and engineering data for all products shall be submitted to the Engineer in accordance with the requirements of Section 01340 of these Specifications.

B. Traffic Control Plan shall be submitted at least 14 days prior to beginning any on-site work.

1.04 Transportation and Handling

A. Unloading: Furnish equipment and facilities for unloading, handling, distributing and storing pipe, fittings, valves and accessories. Make equipment available at all times for use in unloading. Do not drop or dump materials. Any materials dropped or dumped will be subject to rejection without additional justification. Pipe handled on skids shall not be rolled or skidded against the pipe on the ground.

B. Handling: Handle pipe, fittings, valves and accessories carefully to prevent shock or damage. Handle pipe by rolling on skids, forklift, or front end loader. Do not use material damaged in handling. Slings, hooks or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior coatings or internal lining of the pipe.

1.05 Storage and Protection

A. Store all pipe which cannot be distributed along the route. Make arrangements for the use of suitable storage areas.

B. Stored materials shall be kept safe from damage. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times. Valves and hydrants shall be drained and stored in a manner that will protect them from damage by freezing.

C. Pipe shall not be stacked higher than the limits recommended by the manufacturer. The bottom tier shall be kept off the ground on timbers, rails or concrete. Pipe in tiers shall be alternated: bell, plain end; bell, plain end. At least two rows of timbers shall be placed between tiers and chocks, affixed to each other in order to prevent movement. The timbers shall be large enough to prevent contact between the pipe in adjacent tiers.

D. Stored mechanical and push-on joint gaskets shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

E. Mechanical-joint bolts shall be handled and stored in such a manner that will ensure proper use with respect to types and sizes.

1.06 Quality Assurance

The manufacturer shall provide written certification to the Engineer that all products furnished comply with all applicable requirements of these Specifications.

Part 2 Products

2.01 Piping Materials and Accessories

A. All water pipe shall be ductile iron pipe.

B. Ductile Iron Pipe (DIP) and Appurtenances

Use ductile iron pipe that meets the requirements of ANSI/AWWA C151/A21.50 for the class and joint specified. Unless otherwise specified, ductile iron pipe shall be Pressure Class 250 and have nominal laying length of 20 feet.

1. Fittings

Use fittings that meet the requirements of ANSI/AWWA A21.10 or A21.53, a minimum rated working pressure of 250 psi and joint specified. Ends shall be flanged, restrained mechanical joint for pipes and fittings less than 24-inch diameter or restrained push-on to suit the conditions specified. Fittings shall be manufactured in the U.S. Fittings for pipe larger than 24-inches shall have restrained joints as specified below.

2. Rubber Gasket Joints

Use standard styrene butadiene rubber (SBR) gasket joints that meet the requirements of ANSI/AWWA A21.11 for push on mechanical joints.

3. Unrestrained Joints

Unrestrained joints, where specified, shall be the rubber ring compression, push-on type joint suitable for buried service. Unrestrained joints shall be the Fastite Joint as manufactured by U.S. Pipe, or equal. This joint is not permitted on fittings or specials, unless otherwise specified. Unless otherwise specified, joints shall have an allowable deflections up to one-half the manufacturer's allowable deflection. Joint assembly and field cut joints shall be made in strict conformance with AWWA C600 and manufacturer's allowable deflection. Joint assembly

and field cut joints shall be made in strict conformance with AWWA C600 and manufacturer's recommendations.

Where specified, mechanical joints for above or below ground service shall meet the requirements of ANSI/AWWA A21.10/C110 and ANSI/AWWA A21.11/C111. Gaskets and bolts and nuts shall comply with paragraphs 02665-2.01 B2 and 8 respectively.

4. Restrained Joints

Restrained joints shall be provided as shown on the Drawings and where required for thrust restrain. Unless otherwise specified, restrained joints shall be flanged for exposed service and restrained push-on for buried services.

Restrained push-on joints shall be the Flex-Ring (up to 36-inch) or Lok-Ring Joint (42-inch to 64-inch) as manufactured by American Cast iron Pipe Company, TR Flex Joint as manufactured by U.S. Pipe, or equal. Restrained joints shall be capable of being deflected after full assembly. Joint assembly shall be in strict conformance with AWWA C600 and manufacturer's recommendations. No field cuts of restrained pipe are permitted without prior approval of the Engineer.

5. Flanges

Use flanges that meet the requirements of ANSI/AWWA A21.11.

Unless otherwise specified, flanges shall be ductile iron and shall be threaded-on flanges conforming to ANSI/AWWA A21.15/C115 or cast-on flanges conforming to ANSI/AWWA A21.10/C110. Flanges shall be adequate for 250 psi working pressure. Bolt circle and bolt holes shall match those of ANSI B15.1, Class 125 flanges and ANSI B16.5, Class 150 flanges. Where specified, flanges shall be threaded-on or cast-on flanges conforming to ANSI B16.1, Class 250.

Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head bolts with ANSI B18.2.2 standard hexagon nuts. Threads shall be ANSI B1.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5.

Unless otherwise specified, bolts shall be carbon steel machined bolts with hot pressed hexagon nuts. Where washers are required, they shall be of the same material as the associated bolts.

Gaskets for plain faced flanges shall be the full fact type. Thickness shall be 1/16-inch for pipe 10-inches and less in diameter and 1/8-inch for pipe 12-inches and larger in diameter. Unless otherwise specified, gaskets for raised face flanges shall match the raised face and shall be 1/16-inch thick for pipe 3-1/2-inches and less in diameter and 1/8-inch thick for pipe 4-inches and larger.

6. Mechanical Joint Fittings

Restraint devices for mechanical joint fittings shall be Megalug Series 1100 as manufactured by EBAA Iron, Inc., or equal.

Locked mechanical hydrant tees, bends and adapters are in acceptable substitute for anchoring fire hydrants and valves to the pipe main.

7. Ball and Socket Flexible Joint Pipe

   Ball and socket flexible joint pipe shall be the boltless type and shall allow a maximum joint deflection of 15 degrees. Each joint shall be provided with a retainer lock to prevent rotation after assembly. Joints shall be the Flex-Lok Joint as manufactured by American Cast Iron Pipe Company, USIflex as manufactured by U.S. Pipe, or equal.

8. Bolts and Nuts

   a. Provide the necessary bolts for connections. All bolts and nuts shall be threaded in accordance with ANSI B1.1, Coarse Thread Series, Class 2A external and 2B internal fit. All bolts and nuts shall be made in the U.S.A.

   b. Bolts and nuts for mechanical joints shall be Tee Head Bolts and nuts of high strength low-alloy steel in accordance with ASTM A 242 to the dimensions shown in AWWA C111/ANSI A21.11.

   c. Bolts for exposed service shall be zinc plated, cold pressed, steel machine bolts conforming to ASTM A 307, Grade B. Nuts for exposed service shall be zinc plated, heavy hex conforming to ASTM A 563. Zinc plating shall conform to ASTM B 633, Type II.

9. Grooved End Couplings

   Plain end ductile iron pipe may be joined with grooved end couplings and shoulder joints if they meet the requirements of AWWA C606.

   Grooved end flexible-type couplings shall be Victaulic Style 77 or equal. Grooved end rigid-type couplings shall be Victaulic Style 07 or equal. Flexible-type couplings shall be used for all piping greater than 12 inches in diameter; for pipe 12 inches in diameter and less in rack-mounted tunnel piping applications; and for grooved joints adjacent to pump suction and discharge where grooved couplings are used for noise and vibration control. All other applications for piping 12 inches in diameter and less shall utilize rigid-type couplings. Grooved end flanged coupling adapters shall be either Victaulic Style 741 or equal. Snap-joint grooved end couplings shall be Victaulic Style 78 or equal. Cut grooves are not permitted on fabricated or lightwall pipe.

   Unless otherwise specified, bolts and nuts shall comply with AWWA C606. Bolts for submerged service shall be Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

Gaskets shall be as specified in AWWA C 606.

10. Pipe Coating

Unless otherwise specified, pipe and fittings shall be coated with asphaltic material as specified in AWWA C1512.

11. Polyethylene Tube

Polyethylene encasement shall be used where specified. Installation of polyethylene shall be as specified in AWWA C105 and these specifications. Pipe, fittings, valves and couplings shall be wrapped. Fittings that require concrete backing shall be wrapped prior to placing the concrete.

The polyethylene tube seams and overlaps shall be wrapped and held in place by means of a 2 inch wide plastic backed adhesive tape. The tape shall be as recommended by the manufacturer of the pipe and polyethylene tubing. The tape shall be such that the adhesive shall bond securely to both metal surfaces and polyethylene film. Bedding and initial backfill for polyethylene wrapped pipe shall be a well-graded granular material which will not cut or damage the polyethylene tube during placement and backfilling. Sharp angular material over 0.5 inch shall not be used with polyethylene encasement.

12. Pipe Lining

Unless otherwise specified, all interior surfaces of pipe and fittings shall be cement mortar lined in accordance with AWWA C104. Cement shall be ASTM C150, Type II or V, low alkali, containing less than 0.60 percent alkalies.

13. Welded-On Outlets

Welded-on outlets shall be provided where specified. All welded-on outlets shall be rated for a working pressure of 250 psi and shall have a minimum safety factor of 2.0. Welded-on outlets may be provided as a radial (tee) outlet, a tangential outlet, or a lateral outlet. Parent pipe and branch pipe shall meet hydrostatic test requirements in accordance with AWWA C151, section 51-9, prior to fabrication.

All joints on welded-on branch outlets shall be provided in accordance with the latest revision of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA C115/A21.15, as applicable. All outlets shall be fabricated from centrifugally cast ductile iron pipe designed in accordance with ANSI/AWWA C150/A21.50 and manufactured in accordance with ANSI/AWWA C151/A21.51.

All welds must be produced using 55% nickel iron welding rod or wire. Carbon steel electrodes will not be acceptable. Both branch and parent outlet pipe shall be class 53. After fabrication each outlet pipe shall be air tested to 15 psi to insure weld integrity. A soap and water solution shall be applied during the testing procedure to inspect the weld for leakage. Any welds that show air seepage shall be re-fabricated and retested. Welded-on bosses will not be permitted. All welded-on outlets shall be done at manufacturer's plant.

The type of pipe end for the branch outlet shall be as specified or indicated on the drawings. The maximum size and laying length of the welded-on branch outlet shall be recommended by the pipe manufacturer and acceptable to the Engineer for the field conditions and connecting pipe or valve. Pipe embedment material and trench backfill shall be placed and compacted under and around each side of the outlet to hold the pipe in proper position and alignment during subsequent pipe jointing, embedment, and backfilling operations.

14. Thrust collars shall be welded-on ductile iron body type designed to withstand thrust due to 250 psi internal pressure on a dead end.

15. Acceptance will be on the basis of the Engineer's inspection and the manufacturer's written certification that the pipe was manufactured and tested in accordance with the applicable standards.

2.02 Valves

A. Gate Valves (GV)

1. 4-Inches and larger in Diameter: Gate valves shall be resilient wedge type conforming to the requirements of AWWA C509 or AWWA C515 rated for 250 psi working pressure.

a. Valves shall be provided with two O-ring stem seals with one O-ring located above and one O-ring below the stem collar. The area between the O-rings shall be filled with lubricant to provide lubrication to the thrust collar bearing surfaces each time the valve is operated. At least one anti-friction washer shall be utilized to further minimize operating torque. All seals between valve parts, such as body and bonnet, bonnet and bonnet cover, shall be flat gaskets or O-rings.

b. The valve gate shall be made of cast or ductile iron having a vulcanized, synthetic rubber coating, or a seat ring attached to the disc with retaining screws. Sliding of the rubber on the seating surfaces to compress the rubber will not be allowed. The design shall be such that compression-set of the rubber shall not affect the ability of the valve to seal when pressure is applied to either side of the gate. The sealing mechanism shall provide zero leakage at the water working pressure when installed with the line flow in either direction.

c. All internal ferrous surfaces shall be coated with epoxy to a minimum thickness of 4 mils. The epoxy shall be non-toxic, impart no taste to the water and shall conform to AWWA C550.

d. Gate valves shall have a 2-inch square operating nut.

e. Valve ends shall be mechanical joint except where shown otherwise.

f. Manually operated valves shall be non-rising stem type having O-ring seals.

g. Gate valves larger than 4-inches shall be manufactured by American Flow Control, Mueller or M & H Valve.

B. Butterfly Valves

1. Butterfly valves shall be as manufactured by the Henry Pratt Company, or equal.

2. Butterfly valves shall be constructed of the following materials unless otherwise specified:

Component	Material
Shaft	Stainless steel, ASTM A276, Type 304
Disc	ASTM A48, Class 40, or ASTM A126, Class B
Seat mating surface	Stainless steel, ASTM A276, Type 304, mounted in body or on disc edge
Seat sealing surface	EPDM or Buna N
Body	Cast iron, ASTM A126, Class B

3. Valves shall be the stub or through shaft design. Wafer type valves are not acceptable for buried service. Unless otherwise specified, valve flange drilling shall be per ANSI B16.1, Class 125. The stem to disc connection shall be made with pins of the same material as the stainless steel shaft.

4. Valves shall be designed in accordance with AWWA C504 Class 250. Shafts shall be turned, ground and polished. Shaft dimensions and operator torque shall be chosen for the pressure class as specified in AWWA C504. When carbon steel shafts and stainless steel journals are used, static seals shall be provided to isolate the interior of the disc and the shaft from the process fluid.

5. Valves shall have seats that are vulcanized, bonded, mechanically secured, or clamped to the body or disc. For valves, size 30 through 72 inches, valve seats shall be field adjustable and field replaceable. Discs for valves shall be of the flow-through Type with a 360-degree seating design.

6. Manual operators shall be of the traveling nut type with totally enclosed gearing between the valve and the operating wrench nut, meeting all torque and other requirements of Section 3.8.5 of AWWA C504. Operators shall be equipped with adjustable mechanical stop-limiting devices to prevent overtravel of the disc in the open and closed positions and shall be self-locking and designed to hold the valve in any intermediate position between full open and full closed. Valve operator components shall withstand an input torque of 300 ft-lbs at the extreme operator positions without damage.

7. Operator for buried service shall include an AWWA operating nut and shall be gasketed and grease packed for submerged operation at water

pressures to 10 psig. Operators for exposed service shall include a handwheel and be gasketed for weatherproof service.

8. Affidavits of compliance with AWWA C504 shall be provided in accordance with Section 01340.

9. Hydrostatic and leakage tests shall be conducted in strict accordance with AWWA C 504, Section 5, except that leakage test will be performed after the operator has been mounted on the valve.

10. All surfaces of the valve shall be clean, dry and free from grease before painting. The interior and exterior valve surfaces except for disc, seating and finished portions shall receive two coats of asphalt varnish in accordance with Federal Specification TT-V-51C.

2.03 Fire Hydrants (FH)

A. All fire hydrants shall conform to the requirements of AWWA C502 for 150 psi working pressure. Hydrants shall be the compression type, closing with line pressure. The valve opening shall not be less than 5-1/4-inches.

B. In the event of a traffic accident, the hydrant barrel shall break away from the standpipe at a point above grade and in a manner which will prevent damage to the barrel and stem, preclude opening of the valve, and permit rapid and inexpensive restoration without digging or cutting off the water.

C. The means for attaching the barrel to the standpipe shall permit facing the hydrant a minimum of eight different directions.

D. Hydrants shall be fully bronze mounted with all working parts of bronze. Valve seat ring shall be bronze and shall screw into a bronze retainer.

E. All working parts, including the seat ring shall be removable through the top without disturbing the barrel of the hydrant.

F. The operating nut shall match those on the existing hydrants. The operating threads shall be totally enclosed in an operating chamber, separated from the hydrant barrel by a rubber O-ring stem seal and lubricated by a grease or an oil reservoir.

G. Hydrant shall be a non-freezing design and be provided with a simple, positive, and automatic drain which shall be fully closed whenever the main valve is opened.

H. Hose and pumper connections shall be breech-locked, pinned, or threaded and pinned to seal them into the hydrant barrel. Each hydrant shall have two 2-1/2-inch hose connections and one 4-1/2-inch pumper connection, all with National Standard threads and each equipped with cap and non-kinking chain.

I. Hydrants shall be furnished with a mechanical joint connection to the spigot of the 6-inch hydrant lead.

J. Minimum depth of bury shall be 4.5 feet. Provide extension section where necessary for proper vertical installation and in accordance with manufacturer's recommendations.

K. All outside surfaces of the barrel above grade shall be painted with enamel equal to Koppers Glamortex 501, silver in color.

L. Hydrants shall be traffic model and shall be Mueller Super Centurion 250/HS.

2.04 Valve Boxes (VB) and Extension Stems

A. All valves shall be equipped with valve boxes. The valve boxes shall be cast iron two-piece screw type with drop covers. Valve boxes shall have a 5.25-inch inside diameter. Valve box covers shall weigh a minimum of 14 pounds. The valve boxes shall be adjustable to 6-inches up or down from the nominal required cover over the pipe. Valve boxes shall be of sufficient length that bottom flange of the lower belled portion of the box is below the valve operating nut. Ductile or cast iron extensions shall be provided as necessary. Covers shall have "WATER VALVE" or "WATER" cast into them. Valve boxes shall be manufactured in the United States.

B. All valves shall be furnished with stainless steel extension stems, as necessary, to bring the operating nut to within 24-inches of the top of the valve box. Connection to the valve shall be with a wrench nut coupling and a set screw to secure the coupling to the valve's operating nut. The coupling and square wrench nut shall be welded to the extension stem. Extension stems shall be equal to Mueller A-26441 or M & H Valve Style 3801.

2.05 Valve Markers (VM)

The Contractor shall provide a concrete valve marker as detailed on the Drawings for each valve installed.

2.06 Tapping Sleeves and Valves (TS&V)

Tapping sleeves shall be cast or ductile iron of the split-sleeve, mechanical joint type. The Contractor shall be responsible for determining the outside diameter of the pipe to be connected to prior to ordering the sleeve. Valves shall be gate valves furnished in accordance with the specifications shown above, with flanged connection to the tapping sleeve and mechanical joint connection to the branch pipe. The tapping sleeve and valve shall be supplied by the valve manufacturer. Tapping sleeves shall be equal to American Flow Control, Mueller or M & H Valve.

2.07 Manholes, Catch Basins, and Precast Concrete Products

A. Provide precast concrete products in accordance with the following:

1. Precast Concrete Sections

   a. Precast concrete sections shall meet the requirements of ASTM C 478. The minimum compressive strength of the concrete in precast sections shall be 4,000 psi. The minimum wall thickness shall be one-twelfth of the inside diameter of the base, riser or the largest cone diameter.

   b. Transition slabs which convert bases larger than four feet in diameter to four foot diameter risers shall be designed by the precast concrete manufacturer to carry the live and dead loads exerted on the slab.

c. Seal joints between precast sections by means of rubber O-ring gaskets or flexible butyl rubber sealant. Butyl rubber sealants shall meet the requirements of AASHTO M-198. Sealant shall be pre-formed type with a minimum nominal diameter of 1-inch.

d. Butyl rubber sealant shall be equal to Kent Seal No. 2 or Concrete Sealants CS 202.

2. Brick and Mortar: Brick shall be whole and hardburned, conforming to ASTM C 32, Grade MS. Mortar shall be made of one part Portland cement and two parts clean sharp sand. Cement shall be Type 1 and shall conform to ASTM C 150. Sand shall meet ASTM C 144.

3. Iron Castings

a. Cast iron manhole frames, covers and steps shall meet the requirements of ASTM A 48 for Class 30 gray iron and all applicable local standards. All castings shall be tough, close grained, smooth and free from blow holes, blisters, shrinkage, strains, cracks, cold shots and other imperfections. No casting will be accepted which weighs less than 95 percent of the design weight. Shop drawings must indicate the design weight and provide sufficient dimensions to permit checking. All castings shall be thoroughly cleaned in the shop and given two coats of approved bituminous paint before rusting begins.

b. Manhole frames and covers shall be equal to the following:

Type	Design Weight	Manufacturer's Reference	
Bolt Down	400#	Neenah A-1916-F1	Vulcan V-2358

c. All frames and covers shall have machined horizontal bearing surfaces.

4. Plastic Steps: Manhole steps of polypropylene, molded around a steel rod, equal to products of M.A. Industries may be used.

5. Catch Basins

a. Where shown on the Drawings or as required, existing catch basins shall be replaced with a like kind catch basin (inlet). All new and replaced catch basins shall be constructed of reinforced precast concrete, four foot (4') diameter or larger.

b. All catch basins shall be designed and constructed in compliance with Georgia D.O.T. specifications and shall be Georgia DOT 1033D or 1034D standard and shall require a reinforced precast "round to square adapter for additional throat support.

c. In certain cases where rolled or "Hollywood" curb is utilized, the County Engineer (or field Inspector) may require the use of 1033F or 1034F catch basins.

d. Frames, covers and gratings shall be ductile iron designed for heavy-duty traffic services, ASTM A534, Grade 60-40-18, 24-inch clear inside diameter with lettering “Storm Sewer” cast into cover. For structures, more than 5 feet deep, provide steps at 12-inch intervals.

7. Concrete Pipe: When crossing existing sanitary or storm sewer, if it is necessary to remove and replace or replace damaged pipe, as a minimum, replace with reinforced concrete pipe (RCP) conforming to the latest requirements of ASTM C76. Pipe shall be of the class III and shall have circular reinforcement for circular pipe.

2.08 Retainer Glands

A. Retainer glands for ductile iron pipe shall be Megalug Series 1100, as manufactured by EBAA Iron, or Uni-Flange Series 1400, as manufactured by Ford Meter Box Company.

B. Retainer glands shall be provided at all mechanical joints, including fittings, valves, hydrants and other locations as shown on the Drawings.

2.09 Hydrant Tees

Hydrant tees shall be equal to ACIPCO A10180 or U.S. Pipe U-592.

2.10 Anchor Couplings

Lengths and sizes shall be as shown on the Drawings. Anchor couplings shall be equal to ACIPCO A10895 or U.S. Pipe U-591.

2.11 Concrete

Concrete shall have a compressive strength of not less than 3,000 psi, with not less than 5.5 bags of cement per cubic yard and a slump between 3 and 5-inches unless shown or specified otherwise. For job mixed concrete, submit the concrete mix design for approval by the Engineer. Ready-mixed concrete shall be mixed and transported in accordance with ASTM C 94. Reinforcing steel shall conform to the requirements of ASTM A 615, Grade 60.

2.12 Electronic Markers

A. Electronic markers shall be buried with utilities to serve as a locating device. Electronic markers shall be the “Ball” type for a depth up to 4-feet and the “Full Range” type for depths greater than 4-feet. Each marker shall be color coded in accordance with APWA standards and produce an industry specific frequency Each marker shall contain a passive antenna that requires no internal power source. Markers shall be of water resistant polyethylene shells and impervious to minerals, chemicals, and underground temperature extremes. Electronic markers shall be compatible with 3M Dynatel 1420 EMS-iD programmable Marker Locator. Contractor shall supply one Marker Locator for use during installation and shall turn over Locator to County upon project completion. Markers shall be equal to 3M EMS 1423 XR/iD for water service.

B. Have available at all times an electronic pipe locator and a magnetic locator, in good working order, to aid in locating existing pipe lines or other obstructions.

2.13 Air Release and Vacuum Valves

A. Refer to the Valve Schedule in the drawings for valve type, size and location along the project area.

B. Air release valves (ARV) shall have a small venting orifice to vent the accumulation of air and other gases with the line or system under pressure. Size and capacity shall be as specified.

C. Air and vacuum valves (AVV) shall have a large venting orifice to permit the release of air as the line is filling or relieve the vacuum as the line is draining or is under negative pressure. Size and capacity shall be as specified.

D. Combination air valves (CAV) shall have operating features of both the air and vacuum valve and the air release valve. They include both single- and dual-body construction. Size and capacity shall be as specified.

E. Air release and vacuum valves shall be manufactured in compliance with ANSI/AWWA C512 and shall be APCO as manufactured by Valve and Primer Corporation, Crispin as manufactured by Multiplex Manufacturing Company, or equal, modified to provide the specified features and to meet the specified operating conditions.

F. Materials specified below are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

Component	Material
Body, cover	Cast iron, ASTM A126, Grade B
Float	Type 316 SS, ASTM A240
Seat	Buna-N or Type 316 SS
Trim	Type 316 SS, ASTM A240

G. Air release valves shall be float operated, compound lever type, except air release valves less than 1-inch may be simple lever type.

H. Air and vacuum valves shall be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The seat shall be fastened into the valve cover, and shall be easily removed if necessary. The float shall be center or peripheral guided for positive shutoff into the seat.

I. Combination air valves, unless otherwise specified, shall be single-body construction in sizes 1- through 6-inch and dual-body construction in sizes 8-inch and larger. Single-body construction shall be designed to provide all functions within one housing. The body inlet shall be baffled to protect the float and the large and small orifices shall be designed so that during large orifice closure, the small air release orifice will open to allow small amounts of air to escape. Dual-

body construction shall combine one air and vacuum valve and one air release valve with interconnecting piping and gate valve.

J. Valves shall be suitable for pressures up to 250 psi.

K. Air release and vacuum valves shall be installed in accordance with the manufacturer's recommendations. Unless otherwise specified, isolation valves shall be provided below each air valve.

All materials/products that contact potable water must be third party certified as meeting the specifications of ANSI/NSF Standard 61. The certifying party shall be accredited by the ANSI.

Part 3 Execution

3.01 Existing Utilities and Obstructions

A. The Drawings indicate utilities or obstructions that are known to exist according to the best information available to the Owner. The Contractor shall call the Utilities Protection Center (UPC) (404-325-5000 or 1-800-282-7411) as required by Georgia law (Code Section 25-9-1 through 25-9-13) and all utilities, agencies or departments that own and/or operate utilities in the vicinity of the construction work site at least 72 hours (three business days) prior to construction to verify the location of the existing utilities.

B. Existing Utility Location: The following steps shall be exercised to avoid interruption of existing utility service.

1. Provide the required notice to the utility owners and allow them to locate their facilities according to Georgia law. Field utility locations are valid for only 10 days after original notice. The Contractor shall ensure, at the time of any excavation, that a valid utility location exists at the point of excavation.

2. Expose the facility, for a distance of at least 200 feet in advance of pipeline construction, to verify its true location and grade. Repair, or have repaired, any damage to utilities resulting from locating or exposing their true location.

3. Avoid utility damage and interruption by protection with means or methods recommended by the utility owner.

4. Maintain a log identifying when phone calls were made, who was called, area for which utility relocation was requested and work order number issued, if any. The Contractor shall provide the Engineer an updated copy of the log bi-weekly, or more frequently if required.

C. Conflict with Existing Utilities

1. Horizontal Conflict: Horizontal conflict shall be defined as when the actual horizontal separation between a utility, main, or service and the proposed water main does not permit safe installation of the water main by the use of sheeting, shoring, tieing-back, supporting, or temporarily suspending service of the parallel or crossing facility. The Contractor may change the proposed alignment of the water main to avoid

horizontal conflicts if the new alignment remains within the available right-of-way or easement, complies with regulatory agency requirements and after a written request to and subsequent approval by the Engineer. Where such relocation of the water main is denied by the Engineer, the Contractor shall arrange to have the utility, main, or service relocated.

2. Vertical Conflict: Vertical conflict shall be defined as when the actual vertical separation between a utility, main, or service and the proposed water main does not permit the crossing without immediate or potential future damage to the utility, main, service, or the water main. The Contractor may change the proposed grade of the water main to avoid vertical conflicts if the changed grade maintains adequate cover and complies with regulatory agencies requirements after written request to and subsequent approval by the Engineer. Where such relocation of the water main is denied by the Engineer, the Contractor shall arrange to have the utility, main, or service relocated.

D. Electronic Locator: Have available at all times an electronic pipe locator and a magnetic locator, in good working order, to aid in locating existing pipelines or other obstructions.

E. Water and Sewer Separation

1. Water mains should maintain a minimum 10 foot edge-to-edge separation from sewer lines, whether gravity or pressure. If the main cannot be installed in the prescribed easement or right-of-way and provide the 10 foot separation, the separation may be reduced, provided the bottom of the water main is a minimum of 18-inches above the top of the sewer. Should neither of these two separation criteria be possible, the water main shall be installed below the sewer with a minimum vertical separation of 18-inches. Where water mains cross the sewer, or storm drain, the pipe joint adjacent to the pipe crossing the sewer, or storm drain, shall be cut to provide maximum separation of the pipe joints from the sewer, or storm drain.

2. The water main, when installed within 18-inches below the sewer, or storm drain, shall be encased in concrete with a minimum 6-inch concrete depth to the first joint in each direction.

3. No water main shall pass through, or come in contact with, any part of a sanitary sewer manhole.

3.02 Construction Along Highways, Streets and Roadways

A. Install pipe lines and appurtenances along highways, streets and roadways in accordance with the applicable regulations of, and permits issued by, the Georgia Department of Transportation, City, and Fulton County, with reference to construction operations, safety, traffic control, road maintenance and repair.

B. The Contractor shall prepare a Traffic Control Plan and submit the plan to the Engineer at least 14 days prior to on-site work. The Traffic Control Plan shall include all anticipated lane closures, placement of traffic control devices, barricades, lights, flagmen etc. to clearly show how traffic flow and safety will be maintained throughout the project.

C. Traffic Control

1. The Contractor shall provide, erect and maintain all necessary barricades, suitable and sufficient lights and other traffic control devices; provide qualified flagmen where necessary to direct traffic; take all necessary precautions for the protection of the work and the safety of the public. Flagmen shall be certified by a Georgia DOT approved training program.

2. Construction traffic control devices and their installation shall be in accordance with the current Manual On Uniform Traffic Control Devices for Streets and Highways.

3. Placement and removal of construction traffic control devices shall be coordinated with the City and Fulton County a minimum of 48 hours in advance of the activity.

4. Placement of construction traffic control devices shall be scheduled ahead of associated construction activities. Construction time in street right-of-way shall be conducted to minimize the length of time traffic is disrupted. Construction traffic control devices shall be removed immediately following their useful purpose. Traffic control devices used intermittently, such as “Flagmen Ahead”, shall be removed and replaced when needed.

5. Existing traffic control devices within the construction work zone shall be protected from damage. Traffic control devices requiring temporary relocation shall be located as near as possible to their original vertical and horizontal locations. Original locations shall be measured from reference points and recorded in a log prior to relocation. Temporary locations shall provide the same visibility to affected traffic as the original location. Relocated traffic control devices shall be reinstalled in their original locations as soon as practical following construction.

6. Construction traffic control devices shall be maintained in good repair and shall be clean and visible to affected traffic for daytime and nighttime operation. Traffic control devices affected by the construction work zone shall be inspected daily.

7. Construction warning signs shall be black legend on an orange background. Regulatory signs shall be black legend on a white background. Construction sign panels shall meet the minimum reflective requirements of the Georgia Department of Transportation and Fulton County. Sign panels shall be of durable materials capable of maintaining their color, reflective character and legibility during the period of construction.

8. Channelization devices shall be positioned preceding an obstruction at a taper length as required by the current Manual On Uniform Traffic Control Devices for Streets and Highways, as appropriate for the speed limit at that location. Channelization devices shall be patrolled to insure that they are maintained in the proper position throughout their period of use.

D. Construction Operations

1. Perform all work along highways, streets and roadways to minimize interference with traffic.

2. Stripping: Where the pipe line is laid along road right-of-way, strip and stockpile all sod, topsoil and other material suitable for right-of-way restoration.

3. Trenching, Laying and Backfilling: Do not open the trench any further ahead of pipe laying operations than is necessary. Backfill and remove excess material immediately behind laying operations. Complete excavation and backfill for any portion of the trench in the same day.

4. Shaping: Reshape damaged slopes, side ditches, and ditch lines immediately after completing backfilling operations. Replace topsoil, sod and any other materials removed from shoulders.

E. Excavated Materials: Do not place excavated material along highways, streets and roadways in a manner which obstructs more than one lane of traffic, as approved by the Engineer and the City. Sweep all scattered excavated material off of the pavement at the end of each day.

F. Drainage Structures: Keep all side ditches, culverts, cross drains, and other drainage structures clear of excavated material. Care shall be taken to provide positive drainage to avoid ponding or concentration of runoff.

G. Landscaping Features: Landscaping features shall include, but are not necessarily limited to: fences; property corners; cultivated trees and shrubbery; manmade improvements; subdivision and other signs within the right-of-way and easement. The Contractor shall take extreme care in moving landscape features and promptly re-establishing these features.

H. Maintaining Highways, Streets, Roadways and Driveways

1. Maintain streets, highways, roadways and driveways in suitable condition for movement of traffic until completion and final acceptance of the Work.

2. During the time period between pavement removal and completing permanent pavement replacement, maintain highways, streets and roadways by the use of steel running plates. Running plate edges shall have asphalt placed around their periphery to minimize vehicular impact. The backfill above the pipe shall be compacted as specified elsewhere up to the existing pavement surface to provide support for the steel running plates.

3. Furnish a road grader or front-end loader for maintaining highways, streets, and roadways. The grader or front-end loader shall be available at all times.

4. Immediately repair all driveways that are cut or damaged. Maintain them in a suitable condition for use until completion and final acceptance of the Work.

3.03 Pipe Distribution

A. Pipe shall be distributed and placed in such a manner that will not interfere with traffic.

B. No pipe shall be strung further along the route than 500 feet beyond the area in which the Contractor is actually working without written permission from the Owner. The Owner reserves the right to reduce this distance to a maximum distance of 200 feet in residential and commercial areas based on the effects of the distribution to the adjacent property owners.

C. No street or roadway may be closed for unloading of pipe without first obtaining permission from the proper authorities. The Contractor shall furnish and maintain proper warning signs and obstruction lights for the protection of traffic along highways, streets and roadways upon which pipe is distributed.

D. No distributed pipe shall be placed inside drainage ditches or gutters.

E. Distributed pipe shall be placed as far as possible from the roadway pavement, but no closer than five feet from the roadway pavement, as measured edge-to-edge.

3.04 Location and Grade

A. The Drawings show the alignment of the water main and the location of valves, hydrants and other appurtenances.

B. Construction Staking

1. The base lines for locating the principal components of the work adjacent to the work are shown on the Drawings. Base lines shall be defined as the line to which the location of the water main is referenced, i.e., edge of pavement, road centerline, property line, right-of-way or survey line. The Contractor shall be responsible for performing all survey work required for constructing the water main, including the establishment of base lines and any detail surveys needed for construction. This work shall include the staking out of permanent and temporary easements to insure that the Contractor is not deviating from the designated easements.

2. The level of detail of survey required shall be that which the correct location of the water main can be established for construction and verified by the Engineer. Where the location of components of the water main, e.g. tunnels and fittings, are not dimensioned, the establishment on the location of these components shall be based upon scaling these locations from the Drawings with relation to readily identifiable land marks, e.g., survey reference points, power poles, manholes, etc.

C. Reference Points

1. The Contractor shall take all precautions necessary, which includes, but is not necessarily limited to, installing reference points, in order to protect and preserve the centerline or baseline established by the Engineer.

2. Reference points shall be placed, at or no more than three feet, from the outside of the construction easement or right-of-way. The location of the reference points shall be recorded in a log with a copy provided to the Engineer for use, prior to verifying reference point locations. Distances between reference points and the pipeline centerlines shall be accurately measured to 0.01 foot.

3. The Contractor shall give the Engineer reasonable notice that reference points are set. The reference point locations must be verified by the Engineer prior to commencing clearing and grubbing operations.

D. After the Contractor locates and marks the water main centerline or baseline, the Contractor shall perform clearing and grubbing.

E. Construction shall begin at a connection location and proceed without interruption. Multiple construction sites shall not be permitted without written authorization from the Engineer for each site.

F. The Contractor shall be responsible for any damage done to reference points, base lines, center lines and temporary bench marks, and shall be responsible for the cost of re-establishment of reference points, base lines, center lines and temporary bench marks as a result of the operations.

G. Construction Verification Survey allowance: The Construction Verification Survey cash allowance is solely for the use of the Engineer for verification of the Contractor's reference points, centerlines and work performed. The presence of this cash allowance in no way relieves the Contractor of the responsibility of installing reference points, centerlines, temporary bench marks, providing as-built drawings, or verifying that the work has been performed accurately.

3.05 Laying and Jointing Pipe and Accessories

A. Lay all pipe and fittings to accurately conform to the lines and grades established by the Engineer.

B. Pipe Installation

1. Proper implements, tools and facilities shall be provided for the safe performance of the Work. All pipe, fittings, valves and hydrants shall be lowered carefully into the trench by means of slings, ropes or other suitable tools or equipment in such a manner as to prevent damage to water main materials and protective coatings and linings. Under no circumstances shall water main materials be dropped or dumped into the trench.

2. All pipe, fittings, valves, hydrants and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and held for inspection by the Engineer, who may prescribe corrective repairs or reject the materials.

3. All lumps, blisters and excess coating shall be removed from the socket and plain ends of each pipe, and the outside of the plain end and the inside of the bell shall be wiped clean and dry and free from dirt, sand, grit or any foreign materials before the pipe is laid. No pipe containing dirt shall be laid.

4. Foreign material shall be prevented from entering the pipe while it is being placed in the trench. No debris, tools, clothing or other materials shall be placed in the pipe at any time.

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

6. It is not mandatory to lay pipe with the bells facing the direction in which work is progressing.

7. Applying pressure to the top of the pipe, such as with a backhoe bucket, to lower the pipe to the proper elevation or grade, shall not be permitted.

C. Alignment and Gradient

1. Lay pipe straight in alignment and gradient or follow true curves as nearly as practicable. Do not deflect any joint more than 4-degrees or the maximum deflection recommended by the manufacturer, whichever is less.

2. Maintain a transit, level and accessories on the job to lay out angles and ensure that deflection allowances are not exceeded.

D. Expediting of Work: Excavate, lay the pipe, and backfill as closely together as possible. Do not leave unjointed pipe in the trench overnight. Backfill and compact the trench as soon as possible after laying and jointing is completed. Cover the exposed end of the installed pipe each day at the close of work and at all other times when work is not in progress. If necessary to backfill over the end of an uncompleted pipe or accessory, close the end with a suitable plug, either push-on, mechanical joint, restrained joint or as approved by the Engineer.

E. Joint Assembly

1. Push-on, mechanical, flange and restrained type joints shall be assembled in accordance with the manufacturer's recommendations.

2. The Contractor shall inspect each pipe joint within 1,000 feet on either side of main line valves to insure 100 percent seating of the pipe spigot, except as noted otherwise.

3. Each restrained joint shall be inspected by the Contractor to ensure that it has been “homed” 100 percent.

F. Cutting Pipe: Cut ductile iron pipe using an abrasive wheel saw. The Contractor shall cut the pipe and bevel the end, as necessary, to provide the correct length of pipe necessary for installing the fittings, valves, accessories and closure pieces in the correct location. Only push-on and mechanical joint pipes shall be cut.

G. Valve and Fitting Installation

1. Prior to installation, valves shall be inspected for direction of opening, number of turns to open, freedom of operation, tightness of pressure-containing bolting and test plugs, cleanliness of valve ports and especially seating surfaces, handling damage and cracks. Defective valves shall be corrected or held for inspection by the Engineer. Valves shall be closed before being installed.

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

3. A valve box shall be provided on each underground valve. They shall be carefully set, centered exactly over the operating nut and truly plumbed. The valve box shall not transmit shock or stress to the valve. The bottom flange of the lower belled portion of the box shall be placed below the valve operating nut. This flange shall be set on brick, so arranged that the weight of the valve box and superimposed loads will bear on the base and not on the valve or pipe. Extension stems shall be installed where depth of bury places the operating nut in excess of 48-inches beneath finished grade so as to set the top of the operating nut 24-inches below finished grade. The valve box cover shall be flush with the surface of the finished area or such other level as directed by the Engineer.

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

5. A valve marker shall be provided for each underground valve. Unless otherwise detailed on the Drawings or directed by the Engineer, valve markers shall be installed 6-inches inside the right-of-way or easement.

6. If a valve is located in the street and there is a curb, then a “V” mark shall be saw cut in the curb, in line with the valve location.

H. Hydrant Installation

1. Prior to installation, inspect all hydrants for direction of opening, nozzle threading, operating nut and cap nut dimensions, tightness of pressure-containing bolting, cleanliness of inlet elbow, handling damage and cracks. Defective hydrants shall be corrected or held for inspection by the Engineer.

2. All hydrants shall stand plumb and shall have their nozzles parallel with or at right angles to the roadway, with pumper nozzle facing the roadway, except that hydrants having two-hose nozzles 90 degrees apart shall be set with each nozzle facing the roadway at an angle of 45 degrees.

3. Hydrants shall be set to the established grade, with the centerline of the lowest nozzle at least 12-inches above the ground or as directed by the Engineer.

4. Each hydrant shall be connected to the main with a 6-inch branch controlled by an independent 6-inch valve. When a hydrant is set in soil that is pervious, drainage shall be provided at the base of the hydrant by placing coarse gravel or crushed stone mixed with coarse sand from the bottom of the trench to at least 6-inches above the drain port opening in the hydrant to a distance of 12-inches around the elbow.

5. When a hydrant is set in clay or other impervious soil, a 7 cubic yard drainage pit shall be excavated below each hydrant and filled with coarse gravel or crushed stone mixed with coarse sand under and around the elbow of the hydrant and to a level of 6-inches above the drain port.

6. Hydrants shall be located as shown on the Drawings or as directed by the Engineer. As all of the hydrants are intended to fail at the ground-line joint upon vehicle impact, specific care must be taken to provide adequate soil resistance to avoid transmitting shock moment to the lower barrel and inlet connection. Pour a concrete collar approximately 6-inches thick to a diameter of 24-inches at or near the ground line around the hydrant barrel as shown on the Drawings.

I. Polyethylene Encasement: Installation shall be in accordance with AWWA C105 and the manufacturer's instructions. All ends shall be securely closed with tape and all damaged areas shall be completely repaired to the satisfaction of the Engineer.

J. Electronic Markers

1. Electronic markers shall be buried with utilities to serve as a locating device. Electronic markers shall be the "Ball" type for a depth up to 4-feet and the "Full Range" type for depths greater than 4-feet. Each marker shall be color coded in accordance with APWA standards and produce an industry specific frequency. Each marker shall contain a passive antenna that requires no internal power source.

2. Electronic markers will be provided for all water mains. Electronic markers shall be installed every 100 linear feet and as needed to establish a change in direction.

3.06 Connections to Water Mains

A. All connections shall be scheduled with the Engineer and Owner at least 48-hours in advance so as to permit supervision by the Owner.

B. Make connections to existing pipe lines with tapping sleeves and valves, unless specifically shown otherwise on the Drawings.

C. Location: Before laying pipe, locate the points of connection to existing water mains and uncover as necessary for the Engineer to confirm the nature of the connection to be made.

D. Interruption of Services: Make connections to existing water mains only when system operations permit. Operate existing valves only with the specific authorization and direct supervision of the Owner.

E. Tapping Saddles and Tapping Sleeves

1. Holes in the new pipe shall be machine cut, either in the field or at the factory. No torch cutting of holes shall be permitted.

2. Prior to attaching the saddle or sleeve, the pipe shall be thoroughly cleaned, utilizing a brush and rag, as required.

3. Before performing field machine cut, the watertightness of the saddle or sleeve assembly shall be pressure tested. The interior of the assembly shall be filled with water. An air compressor shall be attached, which will induce a test pressure as specified in this Section. No leakage shall be permitted for a period of five minutes.

4. After attaching the saddle or sleeve to an existing main, but prior to making the tap, the interior of the assembly shall be disinfected. All surfaces to be exposed to potable water shall be swabbed or sprayed with a one percent sodium hypochlorite solution.

F. Connections Using Solid Sleeves: Where connections are shown on the Drawings using solid sleeves, the Contractor shall furnish materials and labor necessary to make the connection to the existing pipe line.

G. Connections Using Couplings: Where connections are shown on the Drawings using couplings, the Contractor shall furnish materials and labor necessary to make the connection to the existing pipe line, including all necessary cutting, plugging and backfill.

3.07 Thrust Restraint

A. Provide restraint at all points where hydraulic thrust may develop.

B. Retainer Glands: Provide retainer glands where shown on the Drawings and on all mechanical joints and all associated fittings, valves and related piping. Retainer glands shall be installed in accordance with the manufacturer's recommendations, particularly, the required torque of the set screws. The Contractor shall furnish a torque wrench to verify the torque on all set screws which do not have inherent torque indicators.

C. Hydrants: Hydrants shall be attached to the water main by the following method:

1. The isolation valve shall be attached to the main by connecting the valve to the hydrant tee.

2. The isolation valve shall be attached to the hydrant by providing an anchor coupling between the valve and hydrant, if the hydrant and valve are less than two feet apart. Otherwise, provide ductile iron pipe with retainer glands on the hydrant and valve.

D. Thrust Collars: Collars shall be constructed as shown on the Drawings. Concrete and reinforcing steel shall meet the requirements as specified in this Section. The welded-on collar shall be designed to meet the minimum test pressure specified herein. The welded-on collar shall be attached to the pipe by the pipe manufacturer.

E. Concrete Blocking

1. Provide concrete blocking for all bends, tees, valves, and other points where thrust may develop, except where other exclusive means of thrust restraint are specifically shown on the Drawings.

2. Concrete shall be as specified in this Section.

3. Form and pour concrete blocking at fittings as shown on the Drawings and as directed by the Engineer. Pour blocking against undisturbed earth. Increase dimensions when required by over excavation.

3.08 Inspection and Testing

A. Pressure and Leakage Test

1. All sections of the water main subject to internal pressure shall be pressure tested in accordance with AWWA C600. A section of main will be considered ready for testing after completion of all thrust restraint and backfilling.

2. Each segment of water main between main valves shall be tested individually.

3. Test Preparation

   a. For water mains less than 24-inches in diameter, flush sections thoroughly at flow velocities, greater than 2.5 feet per second, adequate to remove debris from pipe and valve seats. Partially open valves to allow the water to flush the valve seat.

   b. Partially operate valves and hydrants to clean out seats.

   c. Provide temporary blocking, bulkheads, flanges and plugs as necessary, to assure all new pipe, valves, and appurtenances will be pressure tested.

   d. Before applying test pressure, air shall be completely expelled from the pipeline and all appurtenances. Insert corporation cocks at highpoints to expel air as main is filled with water as necessary to supplement automatic air valves. Corporation stops shall be constructed as detailed on the Drawings with a meter box.

   e. Fill pipeline slowly with water. Provide a suitable pump with an accurate water meter to pump the line to the specified pressure.

   f. The differential pressure across a valve or hydrant shall equal the maximum possible, but not exceed the rated working pressure. Where necessary, provide temporary backpressure to meet the differential pressure restrictions.

   g. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure.

4. Test Pressure: Test the pipeline at 250 psi measured at the lowest point for at least two hours. Maintain the test pressure within 5 psi of the specified test pressure for the test duration. Should the pressure drop more than 5 psi at any time during the test period, the pressure shall be restored to the specified test pressure. Provide an accurate pressure gage with graduation not greater than 5 psi.

5. Leakage

a. Leakage shall be defined as the sum of the quantity of water that must be pumped into the test section, to maintain pressure within 5 psi of the specified test pressure for the test duration plus water required to return line to test pressure at the end of the test. Leakage shall be the total cumulative amount measured on a water meter.

b. The Owner assumes no responsibility for leakage occurring through existing valves.

6. Test Results: No test section shall be accepted if the leakage exceeds the limits determined by the following formula:

$$L = \frac{SD\,(P)1/2}{133{,}200}$$

Where: L = allowable leakage, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the leakage test, in pounds per square inch (gauge)
As determined under Section 4 of AWWA C600.

If the water main section being tested contains lengths of various pipe diameters, the allowable leakage shall be the sum of the computed leakage for each diameter. The leakage test shall be repeated until the test section is accepted. All visible leaks shall be repaired regardless of leakage test results.

7. Completion: After a pipeline section has been accepted, relieve test pressure. Record type, size and location of all outlets on record drawings.

3.09 Disinfecting Pipeline

A. After successfully pressure testing each pipeline section, disinfect in accordance with AWWA C651 for the continuous-feed method and these Specifications.

B. Specialty Contractor: Disinfection shall be performed by an approved specialty contractor. Before disinfection is performed, the Contractor shall submit a written procedure for approval before being permitted to proceed with the disinfection. This plan shall also include the steps to be taken for the neutralization of the chlorinated water.

C. Chlorination

1. Apply chlorine solution to achieve a concentration of at least 25 milligrams per liter free chlorine in new line. Retain chlorinated water for 24 hours.

2. Chlorine concentration shall be recorded at every outlet along the line at the beginning and end of the 24 hour period.

3. After 24 hours, all samples of water shall contain at least 10 milligrams per liter free chlorine. Re-chlorinate if required results are not obtained on all samples.

D. Disposal of Chlorinated Water: Reduce chlorine residual of disinfection water to less than one milligram per liter if discharged directly to a body of water or to less than two milligrams per liter if discharged onto the ground prior to disposal. Treat water with sulfur dioxide or other reducing chemicals to neutralize chlorine residual. Flush all lines until residual is equal to existing system.

E. Bacteriological Testing: After final flushing and before the water main is placed in service, the Contractor shall collect samples from the line and have tested for bacteriological quality in accordance with the rules of the Georgia Department of Natural Resources, Environmental Protection Division. Testing shall be performed by a laboratory certified by the State of Georgia. Re-chlorinate lines until required results are obtained.

3.10 Protection and Restoration of Work Area

A. General: Return all items and all areas disturbed, directly or indirectly by work under these Specifications, to their original condition or better, as quickly as possible after work is started.

1. The Contractor shall plan, coordinate, and prosecute the work such that disruption to personal property and business is held to a practical minimum.

2. All construction areas abutting lawns and yards of residential or commercial property shall be restored promptly. Backfilling of underground facilities, ditches, and disturbed areas shall be accomplished on a daily basis as work is completed. Finishing, dressing, and grassing shall be accomplished immediately thereafter, as a continuous operation within each area being constructed and with emphasis placed on completing each individual yard or business frontage. Care shall be taken to provide positive drainage to avoid ponding or concentration of runoff.

3. Handwork, including raking and smoothing, shall be required to ensure that the removal of roots, sticks, rocks, and other debris is removed in order to provide a neat and pleasing appearance.

4. The Department of Transportation's engineer shall be authorized to stop all work by the Contractor when restoration and cleanup are unsatisfactory and to require appropriate remedial measures.

B. Man-Made Improvements: Protect, or remove and replace with the Engineer's approval, all fences, walkways, mail boxes, pipe lines, drain culverts, power and telephone lines and cables, property pins and other improvements that may be encountered in the Work.

C. Cultivated Growth: Do not disturb cultivated trees or shrubbery unless approved by the Engineer. Any such trees or shrubbery which must be removed shall be heeled in and replanted under the direction of an experienced nurseryman.

D. Cutting of Trees: Do not cut trees for the performance of the work except as absolutely necessary. Protect trees that remain in the vicinity of the work from damage from equipment. Do not store spoil from excavation against the trunks. Remove excavated material stored over the root system of trees within 30 days to allow proper natural watering of the root system. Repair any damaged tree over 3-inches in diameter, not to be removed, under the direction of an

experienced nurseryman. All trees and brush that require removal shall be promptly and completely removed from the work area and disposed of by the Contractor. No stumps, wood piles, or trash piles will be permitted on the work site.

E. Disposal of Rubbish: Dispose of all materials cleared and grubbed during the construction of the Project in accordance with the applicable codes and rules of the appropriate county, state and federal regulatory agencies.

3.11 Abandoning Existing Water Mains

A. General: Abandon in place all existing water main segments indicated on the Drawings to be abandoned. Perform abandonment after the new water main has been placed in service and all water main services have been changed over to the new main.

B. Capping and Plugging: Disconnect by sawing or cutting and removing a segment of existing pipe where cutting and capping or plugging is shown on the Drawings or directed by the Engineer. Provide a watertight pipe cap or plug and concrete blocking for restraint to seal off existing mains indicated to remain in service. Seal ends of existing mains to be abandoned with a pipe cap or plug or with a masonry plug and minimum 6-inch cover of concrete on all sides around the end of the pipe. The Contractor shall be responsible for uncovering and verifying the size and material of the existing main to be capped or plugged.

C. Salvaging Materials: Salvage for the Owner existing fire hydrants, valve boxes, valve markers and other materials as indicated on the Drawings or located on water mains abandoned and deliver salvaged items in good condition to the Owner's storage yard. Coordinate delivery and placement of salvaged materials in advance with the Owner, information below.

Attn: Mr. Thomas Czeczil
Department of Public Works
North Fulton Water System
11575-A Maxwell Road
Alpharetta, GA 30004
(770) 360-8853

END OF SECTION

Part 1 General

1.01 Scope

A. This Section includes testing which the Owner may require, beyond that testing required of the manufacturer, to determine if materials provided for the Project meet the requirements of these Specifications.

B. This work also includes all testing required by the Owner to verify work performed by the Contractor is in accordance with the requirements of these Specifications, i.e., concrete strength and slump testing, soil compaction, etc.

C. This work does not include materials testing required in various sections of these Specifications to be performed by the manufacturer, e.g., testing of pipe.

D. The testing laboratory or laboratories will be selected by the Owner. The testing laboratory or laboratories will work for the Owner.

1.02 Payment for Testing Services

A. The cost of testing services required by the Contract to be provided by the Contractor shall be paid for by the Owner through the CASH ALLOWANCE, i.e., concrete testing, soil compaction, and asphalt testing.

B. The cost of additional testing services not specifically required in the Specifications, but requested by the Owner or Engineer, shall be paid for by the Owner through the CASH ALLOWANCE.

C. The cost of material testing described in various sections of these Specifications or as required in referenced standards to be provided by a material manufacturer, shall be included in the price bid for that item and shall not be paid for by the Owner.

D. The cost of retesting any item that fails to meet the requirements of these Specifications shall be paid for by the Contractor. Retesting shall be performed by the testing laboratory working for the Owner.

1.03 Laboratory Duties

A. Cooperate with the Owner, Engineer and Contractor.

B. Provide qualified personnel promptly on notice.

C. Perform specified inspections, sampling and testing of materials.

1. Comply with specified standards, ASTM, other recognized authorities, and as specified.

2. Ascertain compliance with requirements of the Contract Documents.

D. Promptly notify the Engineer and Contractor of irregularity or deficiency of work which are observed during performance of services.

E. Promptly submit three copies (two copies to the Engineer and one copy to the Contractor) of report of inspections and tests in addition to those additional copies required by the Contractor with the following information included:

1. Date issued
2. Project title and number
3. Testing laboratory name and address
4. Name and signature of inspector
5. Date of inspection or sampling
6. Record of temperature and weather
7. Date of test
8. Identification of product and Specification section
9. Location of Project
10. Type of inspection or test
11. Results of test
12. Observations regarding compliance with the Contract Documents

F. Perform additional services as required.

G. The laboratory is not authorized to release, revoke, alter or enlarge on requirements of the Contract Documents, or approve or accept any portion of the Work.

1.04 Contractor Responsibilities

A. Cooperate with laboratory personnel, provide access to Work and/or manufacturer's requirements.

B. Provide to the laboratory, representative samples, in required quantities, of materials to be tested.

C. Furnish copies of mill test reports.

D. Furnish required labor and facilities to:

1. Provide access to Work to be tested;
2. Obtain and handle samples at the site;
3. Facilitate inspections and tests;
4. Build or furnish a holding box for concrete cylinders or other samples as required by the laboratory.

E. Notify the laboratory sufficiently in advance of operation to allow for the assignment of personnel and schedules of tests.

F. Laboratory Tests: Where such inspection and testing are to be conducted by an independent laboratory agency, the sample(s) shall be selected by such

laboratory or agency, or the Engineer, and shipped to the laboratory by the Contractor at Contractor's expense.

G. Copies of all correspondence between the Contractor and testing agencies shall be provided to the Engineer.

1.05 Quality Assurance

Testing shall be in accordance with all pertinent codes and regulations and with procedures and requirements of the American Society for Testing and Materials (ASTM).

1.06 Product Handling

Promptly process and distribute all required copies of test reports and related instructions to insure all necessary retesting or replacement of materials with the least possible delay in the progress of the Work.

1.07 Furnishing Materials

The Contractor shall be responsible for furnishing all materials necessary for testing.

1.08 Code Compliance Testing

Inspections and tests required by codes or ordinances or by a plan approval authority, and made by a legally constituted authority, shall be the responsibility of, and shall be paid for by the Contractor, unless otherwise provided in the Contract Documents.

1.09 Contractor's Convenience Testing

Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

1.10 Schedules for Testing

A. Establishing Schedule

1. The Contractor shall, by advance discussion with the testing laboratory selected by the Owner, determine the time required for the laboratory to perform its tests and to issue each of its findings, and make all arrangements for the testing laboratory to be on site to provide the required testing.

2. Provide all required time within the construction schedule.

B. When changes of construction schedule are necessary during construction, coordinate all such changes of schedule with the testing laboratory as required.

C. When the testing laboratory is ready to test according to the determined schedule, but is prevented from testing or taking specimens due to incompleteness of the Work, all extra costs for testing attributable to the delay will be back charged to the Contractor and shall not be borne by the Owner.

1.11 Taking Specimens

Unless otherwise provided in the Contract Documents, all specimens and samples for tests will be taken by the testing laboratory or the Engineer.

1.12 Transporting Samples

The Contractor shall be responsible for transporting all samples, except those taken by testing laboratory personnel, to the testing laboratory.

END OF SECTION

Part 1 General

1.01 Scope

A. The work covered by this Section includes furnishing all materials and equipment, providing all required labor and installing water meters, water service connections and all appurtenant work according to these Specifications and/or to the Water Connection Detail as shown schematically on the Drawings.

B. Water meters are not to be furnished nor installed. However, the water meter connection must be compatible with the water meters currently used by the Fulton County.

C. No galvanized pipe or fittings shall be used on water services.

1.02 Locations

Locations shall be as close to the existing location or as directed by the Engineer along the route of the water mains.

1.03 Service Compatibility

It is the intent of these Specifications that the water service connections shall duplicate those presently being provided by the Fulton County in order to be compatible with their service maintenance procedures.

1.04 Quality Control

All materials installed under this Section shall have the approval of the NSF for water services.

Part 2 Products

2.01 Materials and Construction

A. Service Line

1. Copper Tubing: Tubing shall be ASTM B 88, Type K, rolled type. Fittings shall be brass with flare connection inlets and outlets, ANSI B16.26. Where required, adapters shall be brass. Unions shall be cast bronze. Joints shall be flare type. All fittings shall be of bronze construction with flare type connections. Individual residential service lines shall be 1-inch copper tubing.

B. Valves and Accessories

1. Ball valves shall be full port bronze, heavy duty type. Valve ends shall be threaded. Valves shall have a minimum 200 psi working pressure for water. Valves shall have stainless steel nut and handle. Valves shall be made in the U.S.A.

2. Corporation Cocks

a. Corporation cocks shall be ground key type, shall be made of bronze conforming to ASTM B61 or B62 and shall be suitable for the working pressure of the system. Ends shall be suitable

for flare type joint. Coupling nut for connection to flared copper tubing shall conform to ANSI B16.26.

b. Corporation cocks shall be equal to Ford FB-600-4.

Part 3 Execution

3.01 General

A. Immediately following completion of the water main system, the Contractor shall install water taps and meter boxes as required. All taps shall remain exposed at the main until the system has been successfully inspected, disinfected and tested for pressure.

B. Installation shall conform to the details for water service connections appearing schematically on the Drawings. Contractor shall provide any and all appurtenant work required to provide the intended water service connections.

C. The Contractor shall be prepared to make emergency repairs to the water system, if necessary, due to damage by others working in the area. In conjunction with this requirement, the Contractor shall furnish and have available at all times, a tapping machine, for the purpose of making temporary water service taps or emergency repairs to damaged water services. The Contractor shall furnish the County a phone number of an individual with the authority to initiate emergency repair work. This number must be provided prior to starting work on the Project.

3.02 Tapping Main

A. All services connected to water main shall be through a 1-inch direct tap, regardless of service and meter size.

B. The water main shall be tapped with a tapping machine specifically designed for that purpose. The tap shall be a direct tap into the water main through a 1-inch brass corporation cock. All taps shall be supervised by the Fulton County engineer. All taps shall be made on the water main at a position so as not to be the top side of the pipe nor the bottom of the pipe. Distance between taps must be a minimum of 12-inches apart.

3.03 Relocation of Service Lines

A. Existing service lines shall be field located by the Contractor. The Contractor shall be responsible for locating existing water meters and determining the existing size service line to reconnect the meters to the new water mains. All service lines installed under existing pavement, including streets, driveways and sidewalks, shall be installed by free boring. If deemed necessary and directed by the Engineer, the Contractor may be required to relocate the existing meters and meter boxes. Relocated meters and meter boxes shall conform to installation requirements for new meters as shown on the Drawings.

B. Copper tubing (Type K) between tap and water meter shall be one continuous length of pipe with no intermediate joints or connections. The service line shall be placed without sharp turns or bends from the water main to the meter box.

3.04 Transfer of Service

A. Immediately before connecting to the relocated or existing meter, all service lines shall be flushed to remove any foreign matter. Any special fittings required to reconnect the existing meter to the new copper service line, or the existing private service line, shall be provided by the Contractor. To minimize out of service time, the Contractor shall determine the connections to be made and have all the required pipe and fittings on hand before shutting off the existing service. After completing the connection, the new corporation stop shall be opened and all visible leaks shall be repaired.

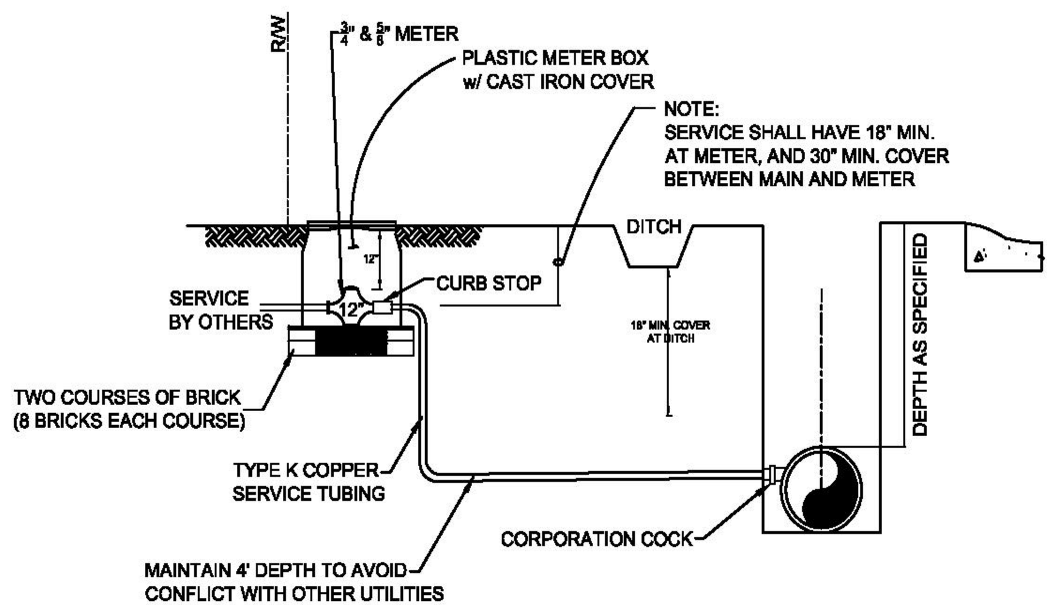
3.05 Maintenance and Repairs

A. The tap, service line and meter box shall remain under the Contractor's maintenance responsibility for the same warranty period as the water main. The contractor shall promptly repair any damage to the water system during the warranty period.

END OF SECTION

APPENDIX A

Fulton County Standard Details



NOTES:

1. SERVICE LINE SHALL BE 3/4" DIAMETER FROM MAIN TO METER
2. USE ALL FLARE JOINTS
3. INSTALLATION SHALL ALLOW ADEQUATE ROOM TO REMOVE AND/OR REPAIR METER.
4. METER BOX SHALL BE APPROXIMATELY 12" x 18".
5. TYPE K COPPER SERVICE LINE MUST BE CONTINUOUS FROM METER TO MAIN
6. NEW WATER MAIN SUBJECT TO 250LB PRESSURE TEST FOR TWO HOURS.

FULTON COUNTY STANDARD DETAIL 801
3/4" & 5/8" METER INSTALLATION

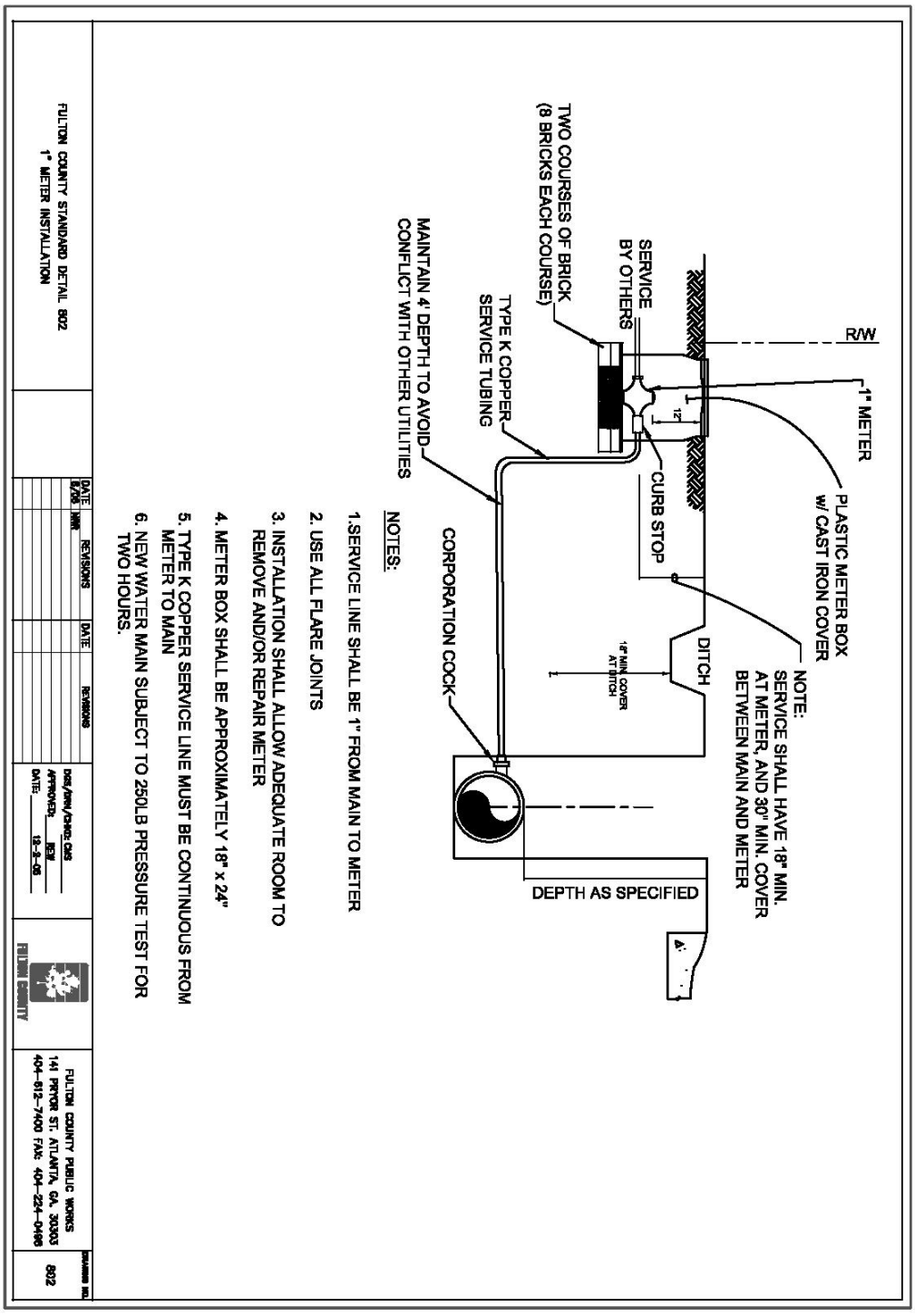
DATE	REVISIONS	DATE	REVISIONS
5/05	NRR		

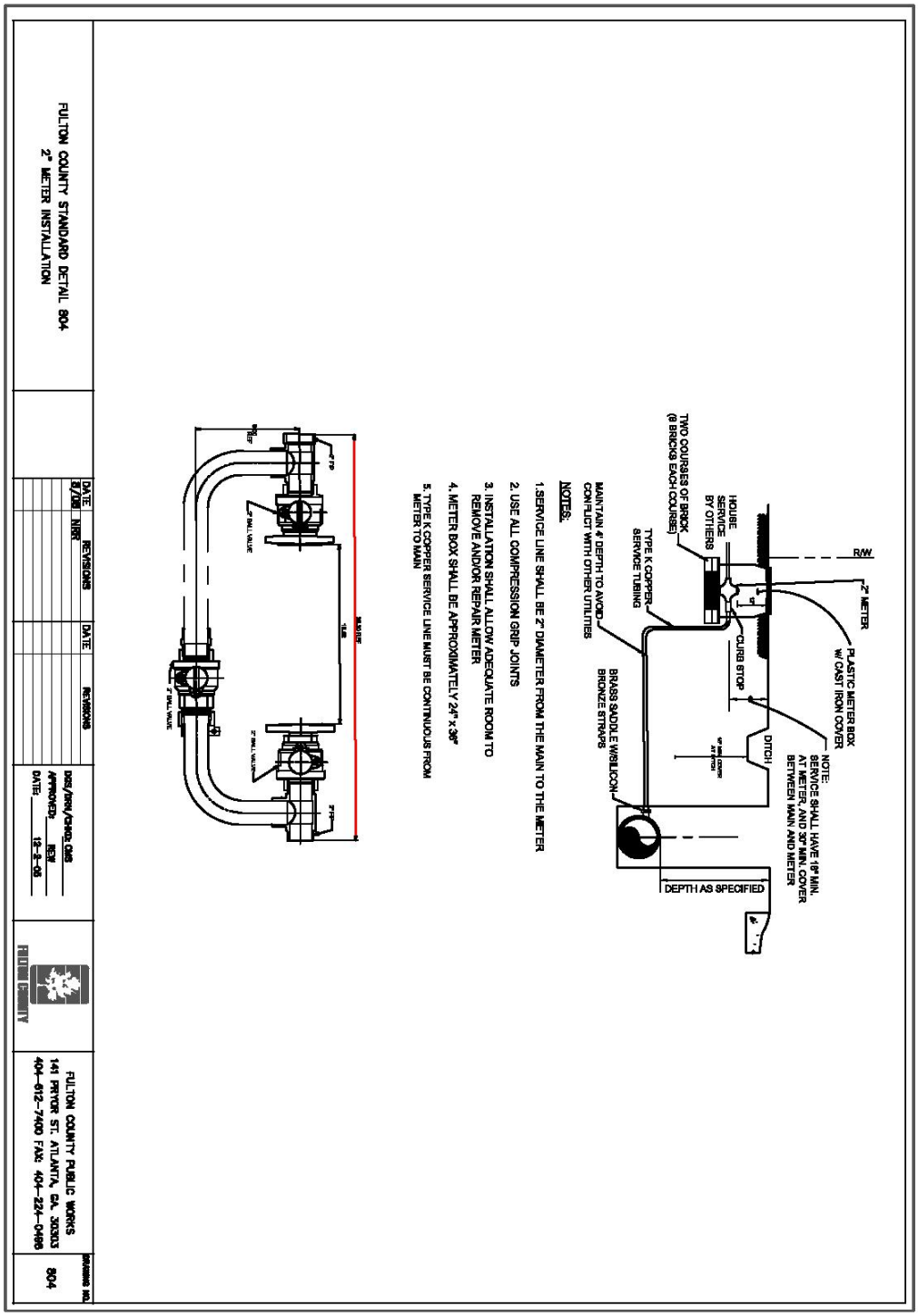
DGS/DRN/CHKD: CMS
APPROVED: REW
DATE: 12-2-05

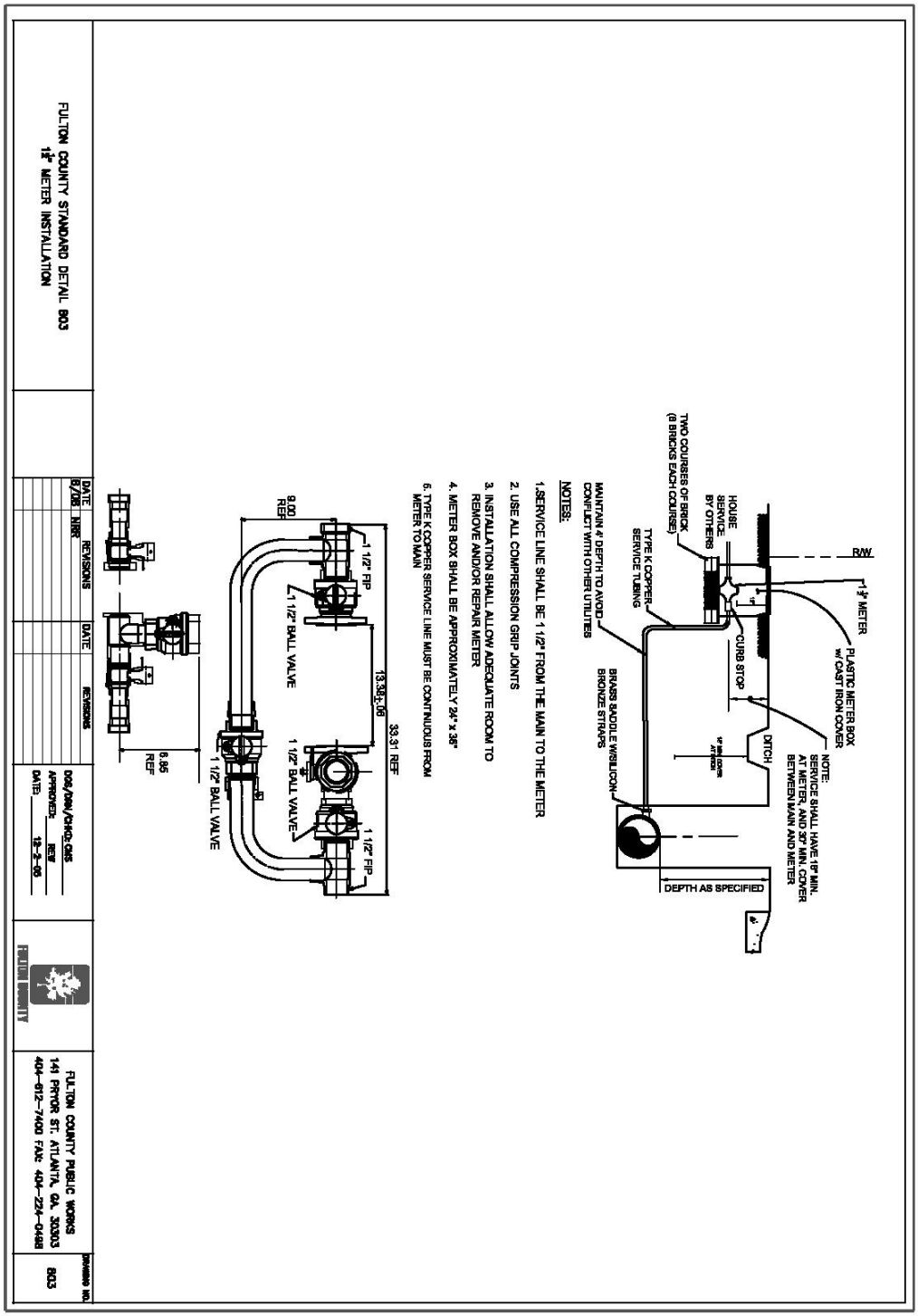
FULTON COUNTY

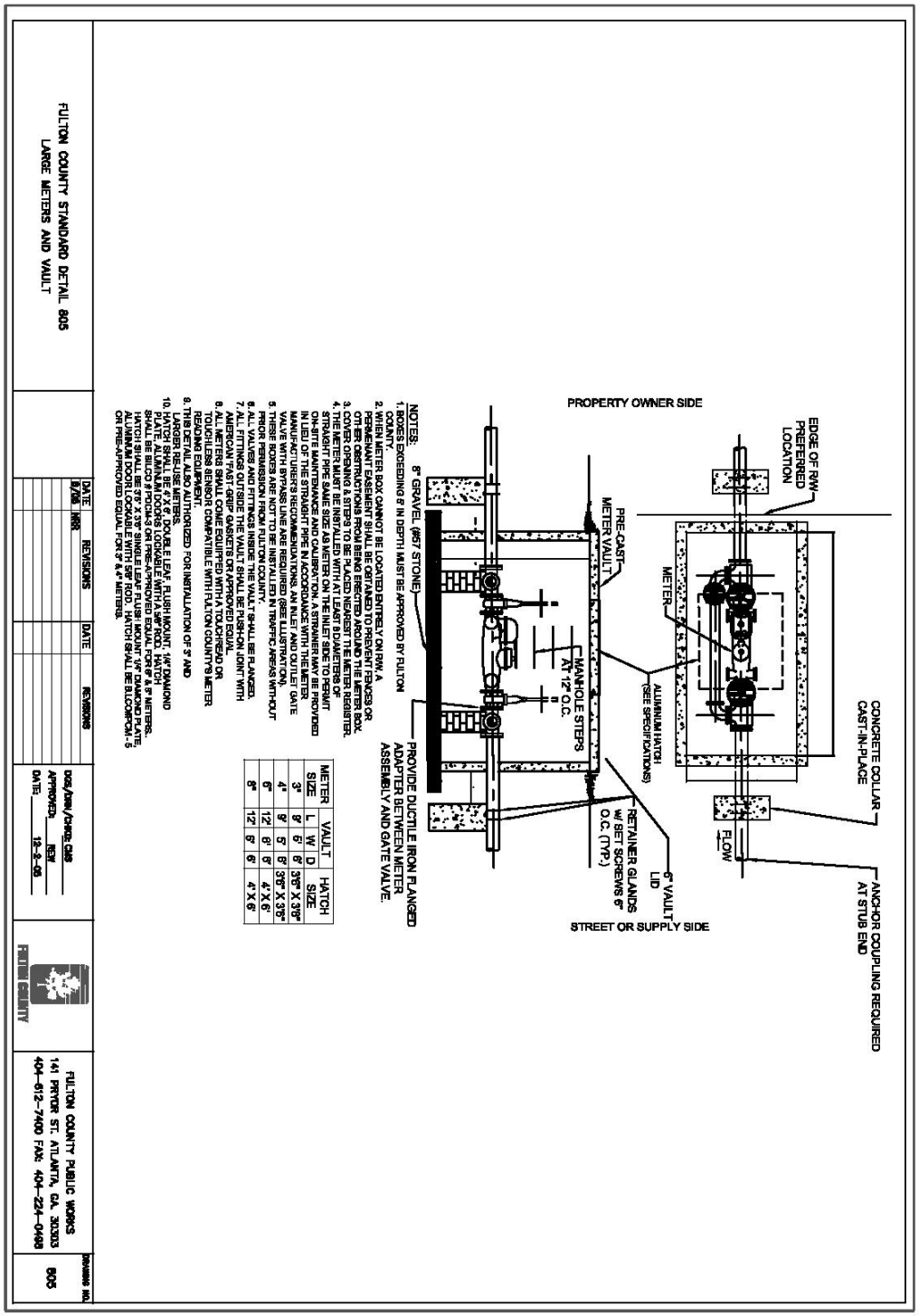
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0495

DRAWING NO. 801


R/W
1" METER
PLASTIC METER BOX
w/ CAST IRON COVER
NOTE:
SERVICE SHALL HAVE 18" MIN.
AT METER, AND 30" MIN. COVER
BETWEEN MAIN AND METER
SERVICE
BY OTHERS
TWO COURSES OF BRICK
(8 BRICKS EACH COURSE)
TYPE K COPPER
SERVICE TUBING
MAINTAIN 4' DEPTH TO AVOID
CONFLICT WITH OTHER UTILITIES
CURB STOP
DITCH
18" MIN COVER
AT DITCH
CORPORATION COCK
DEPTH AS SPECIFIED
NOTES:
1.SERVICE LINE SHALL BE 1" FROM MAIN TO METER
2. USE ALL FLARE JOINTS
3. INSTALLATION SHALL ALLOW ADEQUATE ROOM TO
REMOVE AND/OR REPAIR METER
4. METER BOX SHALL BE APPROXIMATELY 18" x 24"
5. TYPE K COPPER SERVICE LINE MUST BE CONTINUOUS FROM
METER TO MAIN
6. NEW WATER MAIN SUBJECT TO 250LB PRESSURE TEST FOR
TWO HOURS.
FULTON COUNTY STANDARD DETAIL 802
1" METER INSTALLATION
DATE
BY/DR
REVISIONS
DATE
REVISIONS
DSGN/DRWN/CHKD: CMS
APPROVED: BEM
DATE: 10-3-08
FULTON COUNTY
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0486
802


FULTON COUNTY STANDARD DETAIL 804
2" METER INSTALLATION
R/W
2" METER
HOUSE SERVICE BY OTHERS
TWO COURSES OF BRICK (8 BRICKS EACH COURSE)
TYPE K COPPER SERVICE TUBING
CURB STOP
PLASTIC METER BOX w/ CAST IRON COVER
NOTE: SERVICE SHALL HAVE 18" MIN. AT METER AND 30" MIN. COVER BETWEEN MAIN AND METER
DITCH
MAINTAIN 4' DEPTH TO AVOID CONFLICT WITH OTHER UTILITIES
BRASS SADDLE W/SILICON BRONZE STRAPS
DEPTH AS SPECIFIED
NOTES:
1. SERVICE LINE SHALL BE 2" DIAMETER FROM THE MAIN TO THE METER
2. USE ALL COMPRESSION GRIP JOINTS
3. INSTALLATION SHALL ALLOW ADEQUATE ROOM TO REMOVE AND/OR REPAIR METER
4. METER BOX SHALL BE APPROXIMATELY 24" x 36"
5. TYPE K COPPER SERVICE LINE MUST BE CONTINUOUS FROM METER TO MAIN
DATE
BY
REVISIONS
DATE
REVISIONS
DRWG/DWG/CHKD
APPROVED:
DATE:
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0488
DRAWING NO.
804


FULTON COUNTY STANDARD DETAIL 803
1½" METER INSTALLATION
DATE
BY
REVISIONS
DATE
REVISIONS
DOE/DRW/CHKD: DMS
APPROVED: REE
DATE: 12-2-98
FULTON COUNTY
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0488
DRAWING NO.
803
R/W
1½" METER
PLASTIC METER BOX w/ CAST IRON COVER
NOTE: SERVICE SHALL HAVE 18" MIN. AT METER, AND 30" MIN. COVER BETWEEN MAIN AND METER
CURB STOP
DITCH
HOUSE SERVICE BY OTHERS
TWO COURSES OF BRICK (8 BRICKS EACH COURSE)
TYPE K COPPER SERVICE TUBING
MAINTAIN 4' DEPTH TO AVOID CONFLICT WITH OTHER UTILITIES
BRASS SADDLE W/SILICON BRONZE STRAPS
DEPTH AS SPECIFIED
NOTES:
1. SERVICE LINE SHALL BE 1 1/2" FROM THE MAIN TO THE METER
2. USE ALL COMPRESSION GRIP JOINTS
3. INSTALLATION SHALL ALLOW ADEQUATE ROOM TO REMOVE AND/OR REPAIR METER
4. METER BOX SHALL BE APPROXIMATELY 24" x 36"
5. TYPE K COPPER SERVICE LINE MUST BE CONTINUOUS FROM METER TO MAIN
1 1/2" FIP
9.00 REF
1 1/2" BALL VALVE
13.30±.06
33.31 REF
1 1/2" BALL VALVE
1 1/2" FIP
6.85 REF



NOTES:

1. BOXES EXCEEDING 6' IN DEPTH MUST BE APPROVED BY FULTON COUNTY.
2. WHEN METER BOX CANNOT BE LOCATED ENTIRELY ON R/W, A PERMANENT EASEMENT SHALL BE OBTAINED BY OWNER. NO OBSTRUCTIONS FROM BEING ERECTED AROUND THE METER BOX.
3. COVER OPENING & STEPS TO BE PLACED NEAREST THE METER REGISTER.
4. THE METER MUST BE INSTALLED WITH AT LEAST 5 DIAMETERS OF STRAIGHT PIPE SAME SIZE AS METER ON THE INLET SIDE TO PERMIT ON-SITE MAINTENANCE AND CALIBRATION. A STRAINER MAY BE PROVIDED IN LIEU OF THE STRAIGHT PIPE IMMEDIATELY AHEAD OF THE METER.
5. THESE BOXES ARE NOT TO BE INSTALLED IN TRAFFIC AREAS WITHOUT PRIOR PERMISSION FROM FULTON COUNTY.
6. ALL VALVES AND FITTINGS INSIDE THE VAULT SHALL BE FLANGED.
7. ALL FITTINGS OUTSIDE THE VAULT SHALL BE PUSH-ON JOINT WITH MECHANICAL JOINT GLAND AS REQUIRED.
8. THIS DETAIL ALSO AUTHORIZED FOR INSTALLATION OF 3" AND LARGER RE-USE METERS.
9. ALL METERS SHALL COME EQUIPPED WITH A TOUCHREAD OR TOUCHLESS SENSOR COMPATIBLE WITH FULTON COUNTY'S METER READING EQUIPMENT.
10. LARGER RE-USE METERS, DOUBLE LEAF, FLUSH MOUNT, 14# DIAMOND PLATE, ALUMINUM DOORS LOCKABLE WITH A 3# ROD. HATCH SHALL BE BILCO # PDCM-3 OR PRE-APPROVED EQUAL FOR 3" & 4" METERS. HATCH SHALL BE 70" X 93" SINGLE LEAF FLUSH MOUNT 1/4" DIAMOND PLATE, ALUMINUM DOOR LOCKABLE WITH A 3/4" ROD. HATCH SHALL BE BILCO #SD-2 OR PRE-APPROVED EQUAL FOR 6" & 8" METERS.

METER SIZE	VAULT L	W	D	HATCH SIZE
3"	8'	5'	8'	36" X 36"
4"	8'	5'	8'	36" X 36"
6"	12'	8'	8'	4' X 6'
8"	12'	8'	8'	4' X 6'

DATE BY	MK	REVISIONS	DATE	REVISIONS

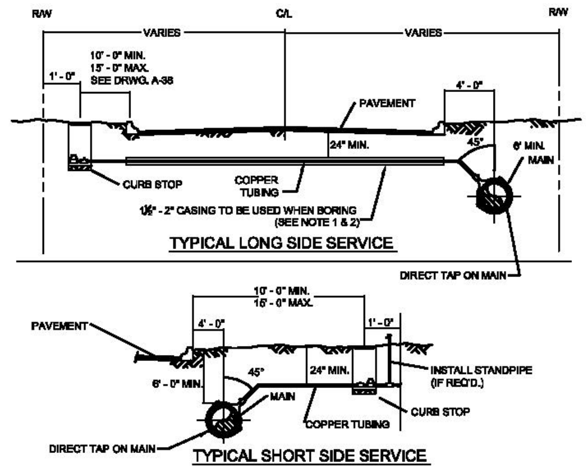
DSGN/DRN/CHKD: GMB
APPROVED: RSH
DATE: 12-2-05

FULTON COUNTY STANDARD DETAIL 805
LARGE METERS AND VAULT

FULTON COUNTY

FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0468

DRAWING NO. 805



NOTES

1. IN THE EVENT CASING IS NOT PRESENT ON LONG SIDE LOT, BORING SHALL BE PERMITTED. WHEN CASING DOES EXIST - 1" OR ¾" PIPE SHALL BE INSERTED THROUGH CASING TO COMPLETE THE INSTALLATION FROM THE MAIN TO THE METER.
2. APPROVAL MUST BE OBTAINED BY FULTON COUNTY DEPARTMENT OF PUBLIC WORKS TRANSPORTATION DIVISION. PRIOR TO ROAD CUT, THE PUBLIC WORKS WATER SERVICES DIVISION DOES NOT HAVE THE AUTHORITY TO APPROVE ROAD CUTS, NO ROAD CUT SHALL BE PERMITTED UNTIL 3 ATTEMPTS HAVE BEEN MADE AT BORING OR LOCATING CASING.
3. 24" COVER (MIN.) FROM SURFACE TO TOP OF SERVICE PIPE APPLIES TO COUNTY MAINTAINED ROADS FOR STATE ROADS SAID MINIMUM CLEARANCE SHALL BE 48".
4. ALL CUTS IN PAVEMENT SHALL BE REPAIRED IN ACCORDANCE WITH EITHER GA. D.O.T. OR FULTON CO. STANDARDS. CONTRACTOR SHALL BE RESPONSIBLE FOR PROPER DITCH COMPACTION, CUT BACK OF DITCH SIDES AND PAVING OF THE REQUIRED CONCRETE SUB-BASE AND PLATING THE DITCH TO ALLOW TRAFFIC FLOW WHILE CONCRETE IS SETTING UP. STEEL TRAFFIC PLATES WILL COVER POURED CONCRETE FOR A MINIMUM OF 24 HOURS.
5. METERS ARE TO BE SET DIRECTLY OPPOSITE TAP ON MAIN. THE METER SHALL NOT BE OFFSET LATERALLY FROM TAP ON WATER MAIN.

FULTON COUNTY STANDARD DETAIL 806
¾" – 1" METER SETTING
SHORT AND LONG SIDES

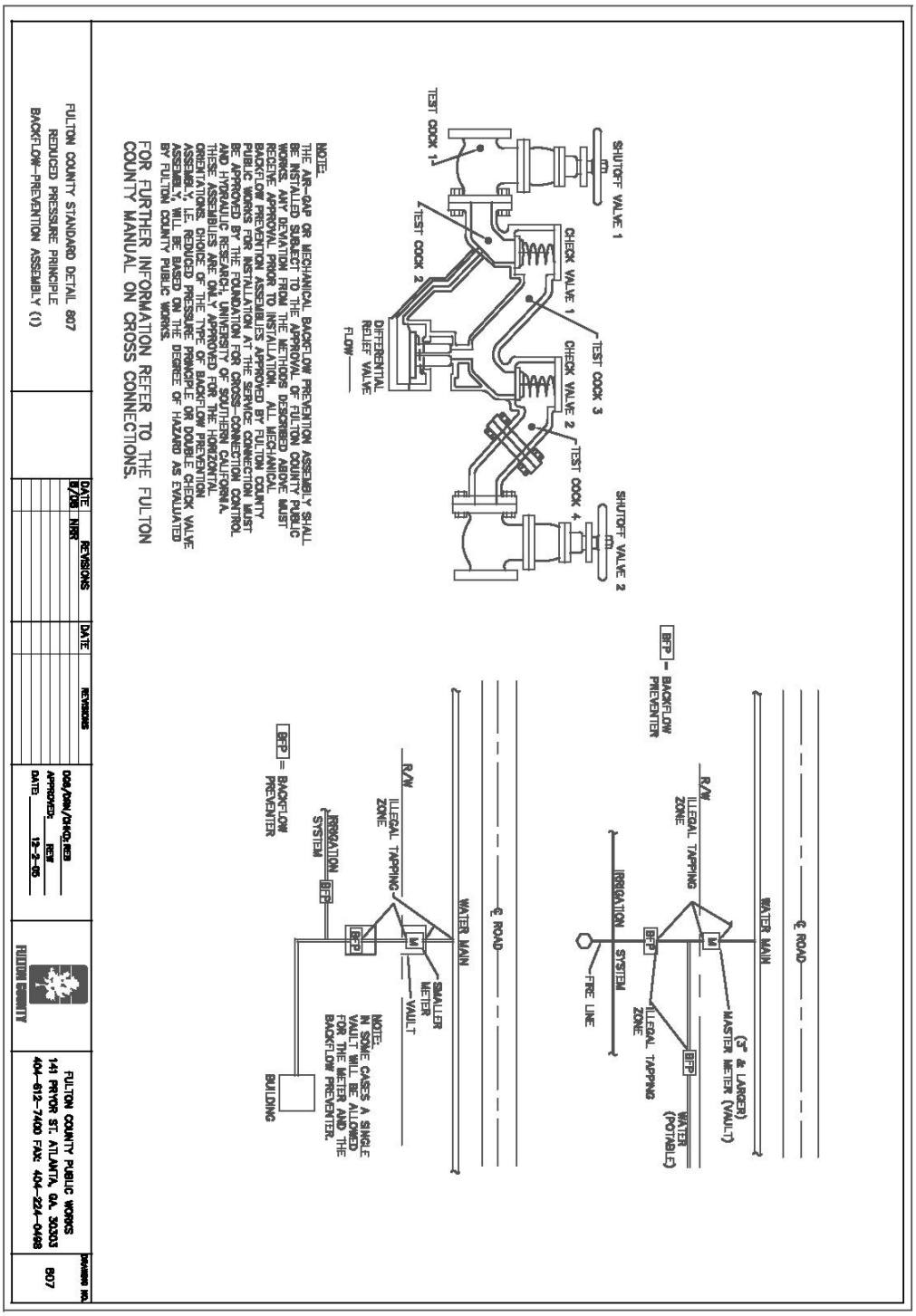
DATE	REVISIONS	DATE	REVISIONS
5/08	NRR		

DGS/DRN/CHKD: CMS
APPROVED: ML
DATE: 12-2-08

FULTON COUNTY

FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0498

DRAWING NO. 806



FULTON COUNTY STANDARD DETAIL 807
REDUCED PRESSURE PRINCIPLE
BACKFLOW-PREVENTION ASSEMBLY (1)

DATE	REVISIONS
8/08	NRK

DATE	REVISIONS

006/DWN/SHEQ.RE3
APPROVED: REK
DATE: 12-2-05

FULTON COUNTY

FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0498

DRAWING NO.
807

REDUCED – PRESSURE PRINCIPLE BACKFLOW PREVENTION ASSEMBLY (RPBA)

DESCRIPTION

THE APPROVED REDUCED-PRESSURE PRINCIPLE BACKFLOW-PREVENTION ASSEMBLY CONSISTS OF TWO INDEPENDENTLY ACTING, APPROVED CHECK VALVES TOGETHER WITH A HYDRAULICALLY OPERATING, MECHANICALLY INDEPENDENT PRESSURE DIFFERENTIAL RELIEF VALVE LOCATED BETWEEN THE CHECK VALVES AND BELOW THE FIRST CHECK VALVE. THESE UNITS ARE LOCATED BETWEEN TWO TIGHTLY CLOSING RESILIENT-SEATED SHUTOFF VALVES, AS AN ASSEMBLY, AND ARE EQUIPPED WITH PROPERLY LOCATED RESILIENT-SEATED TEST COCKS AS SHOWN.

APPLICATION

THE RPBA IS EFFECTIVE AGAINST BACKFLOW CAUSED BY BACKPRESSURE AND BACKSIPHONAGE.
THE RPBA IS NORMALLY USED IN LOCATIONS WHERE AN APPROVED AIR GAP IS IMPRACTICAL.

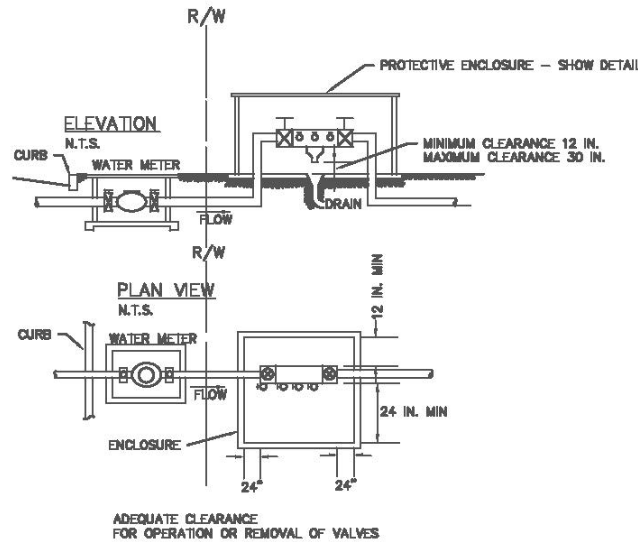
INSTALLATION

THE RPBA SHALL BE INSTALLED WITH ADEQUATE SPACE TO FACILITATE MAINTENANCE AND TESTING. THE INSTALLATION SHOULD NOT REQUIRE PLATFORMS, LADDERS, OR LIFTS FOR ACCESS.
ADEQUATE CLEARANCE FROM THE FLOOR, CEILING, AND WALLS MUST BE PROVIDED TO FACILITATE THE REMOVAL OF THE RELIEF VALVE AND/OR CHECK VALVES.

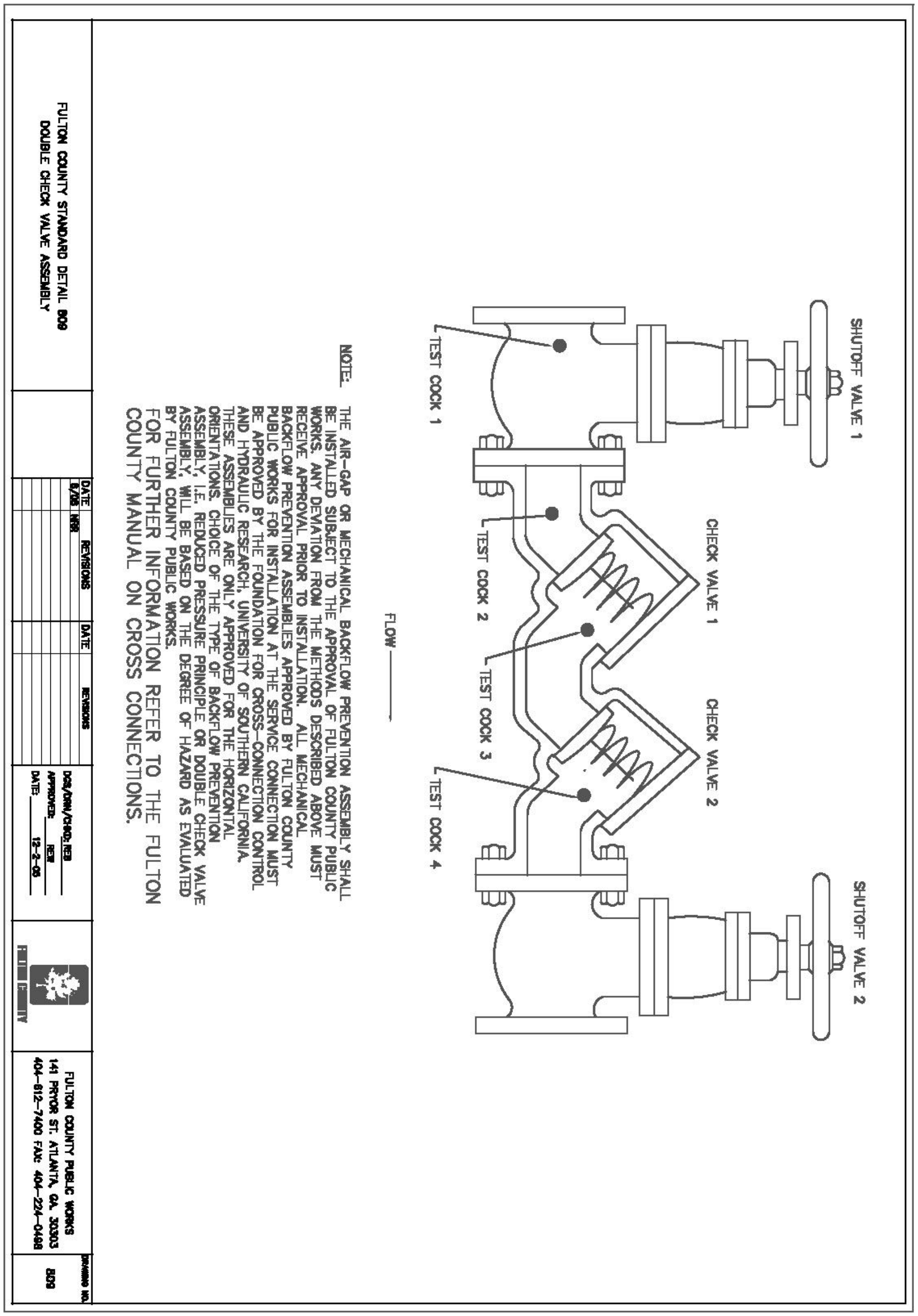
AN RPBA MUST BE PROTECTED FROM FREEZING TEMPERATURES AND IF INSTALLED WHERE TEMPERATURES WILL REACH 110 DEGREES FAHRENHEIT (43 DEGREES CELSIUS) OR ABOVE, THE HOT-WATER TYPE OF ASSEMBLY MUST BE USED.
CONSULT MANUFACTURER'S SPECIFICATIONS FOR RECOMMENDATIONS.
AN RPBA SHALL NOT BE INSTALLED IN A PIT BELOW GROUND LEVEL. SEMIBURIED PITS ARE ACCEPTABLE IF THE RPBA IS INSTALLED ABOVE THE GROUND OR THE MAXIMUM FLOOD LEVEL WITH THE APPROVED AIR GAP BETWEEN THE RELIEF VALVE PORT AND THE DAYLIGHT DRAIN.
THE DAYLIGHT DRAIN FROM ABOVE GROUND OR SEMIBURIED VAULTS MUST PROVIDE: ADEQUATE DRAINAGE FOR THE DISCHARGE FROM THE REDUCED-PRESSURE PRINCIPLE ASSEMBLY RELIEF VALVE PORT.
ACCESS FOR MAINTENANCE AND PERIODIC TESTING MUST ALSO BE PREPARED.

BEFORE INSTALLING AN RPBA, ENSURE THAT THE RELIEF VALVES ARE IN GOOD WORKING CONDITION.
IF THE RPBA IS LOCATED INSIDE A BUILDING, A DRAIN MUST BE PROVIDED TO RECEIVE SPILLAGE FROM THE RELIEF VALVE PORT. THE RELIEF VALVE PORT MUST ALWAYS HAVE AN APPROVED AIR GAP BETWEEN IT AND THE DRAIN OR MAXIMUM FLOOD LEVEL, WHICHEVER IS HIGHEST.
ALL REDUCED-PRESSURE PRINCIPLE ASSEMBLIES SHALL BE INSTALLED IN THE

THE RPBA SHALL NOT BE INSTALLED IN AN AREA WHERE CORROSIVE FUMES OR GASES COULD RENDER THE ASSEMBLY INOPERABLE.



FULTON COUNTY STANDARD DETAIL 808 REDUCED PRESSURE PRINCIPLE BACKFLOW-PREVENTION ASSEMBLY (2)	DATE 8/08	REVISIONS NRR	DATE	REVISIONS	DGS/DRN/CHKD: REB APPROVED: REW DATE: 12-2-05	FULTON COUNTY	FULTON COUNTY PUBLIC WORKS 141 PRYOR ST. ATLANTA, GA. 30303 404-612-7400 FAX: 404-224-0498	DRAWING NO. 808


SHUTOFF VALVE 1
CHECK VALVE 1
CHECK VALVE 2
SHUTOFF VALVE 2
FLOW
TEST COCK 1
TEST COCK 2
TEST COCK 3
TEST COCK 4
NOTE:
THE AIR-GAP OR MECHANICAL BACKFLOW PREVENTION ASSEMBLY SHALL BE INSTALLED SUBJECT TO THE APPROVAL OF FULTON COUNTY PUBLIC WORKS. ANY DEVIATION FROM THE METHODS DESCRIBED ABOVE MUST RECEIVE APPROVAL PRIOR TO INSTALLATION. ALL MECHANICAL BACKFLOW PREVENTION ASSEMBLIES APPROVED BY FULTON COUNTY PUBLIC WORKS FOR INSTALLATION AT THE SERVICE CONNECTION MUST BE APPROVED BY THE FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH, UNIVERSITY OF SOUTHERN CALIFORNIA. THESE ASSEMBLIES ARE ONLY APPROVED FOR THE HORIZONTAL ORIENTATIONS. CHOICE OF THE TYPE OF BACKFLOW PREVENTION ASSEMBLY, I.E. REDUCED PRESSURE PRINCIPLE OR DOUBLE CHECK VALVE ASSEMBLY, WILL BE BASED ON THE DEGREE OF HAZARD AS EVALUATED BY FULTON COUNTY PUBLIC WORKS.
FOR FURTHER INFORMATION REFER TO THE FULTON COUNTY MANUAL ON CROSS CONNECTIONS.
FULTON COUNTY STANDARD DETAIL 809
DOUBLE CHECK VALVE ASSEMBLY
DATE
8/08
NRR
REVISIONS
DATE
REVISIONS
DSG/DRN/CHKD: REB
APPROVED: REW
DATE: 12-2-05
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0468
DRAWING NO.
809

DOUBLE CHECK VALVE ASSEMBLE (DCVA)

DESCRIPTION

THIS ASSEMBLY CONSISTS OF TWO INTERNALLY LOADED CHECK VALVES, EITHER SPRING–LOADED OR INTERNALLY WEIGHTED, INSTALLED AS A UNIT BETWEEN TWO TIGHTLY CLOSING RESILIENT–SEATED SHUTOFF VALVES AS AN ASSEMBLY, AND FITTINGS WITH PROPERLY LOCATED RESILIENT–SEATED TEST COCKS AS SHOWN.

APPLICATION

THE DCVA IS EFFECTIVE AGAINST BACKFLOW CAUSED BY BACKPRESSURE AND BACKSIPHONAGE AND IS USED TO PROTECT THE WATER SYSTEM FROM POLLUTANTS THAT WOULD NOT CONSTITUTE AN ACTUAL HEALTH HAZARD, BUT THAT MIGHT BE OBJECTIONABLE TO THE WATER SUPPLY SYSTEM.

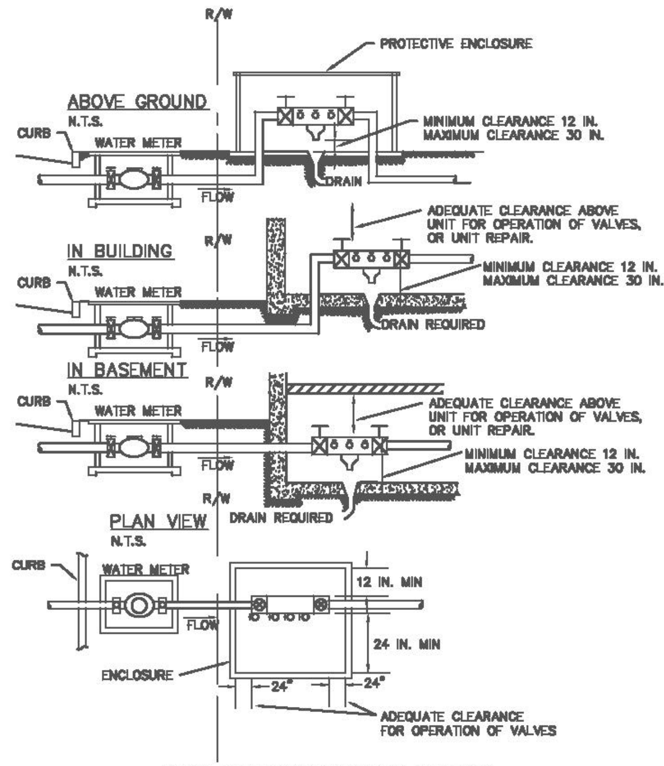
INSTALLATION

THE DCVA SHOULD BE INSTALLED WITH ADEQUATE SPACE TO FACILITATE MAINTENANCE AND TESTING AND SHOULD HAVE FREE ACCESS WITHOUT THE USE OF PLATFORMS, LADDERS, OR LIFTS.

A DCVA SHOULD NOT BE INSTALLED BELOW GROUND LEVEL UNLESS PROVIDED WITH ADEQUATE DRAINAGE TO MAINTAIN A DRY LOCATION. WHERE AN ASSEMBLY MUST BE INSTALLED IN A LOCATION THAT IS SUSCEPTIBLE TO FLOODING, SUCH AS A BASEMENT, THE TEST COCKS SHALL BE PLUGGED.

ALL DCVAS SHALL BE INSTALLED IN A HORIZONTAL POSITION UNLESS OTHERWISE RECOMMENDED BY THE MANUFACTURER AND/OR FULTON COUNTY PUBLIC WORKS.

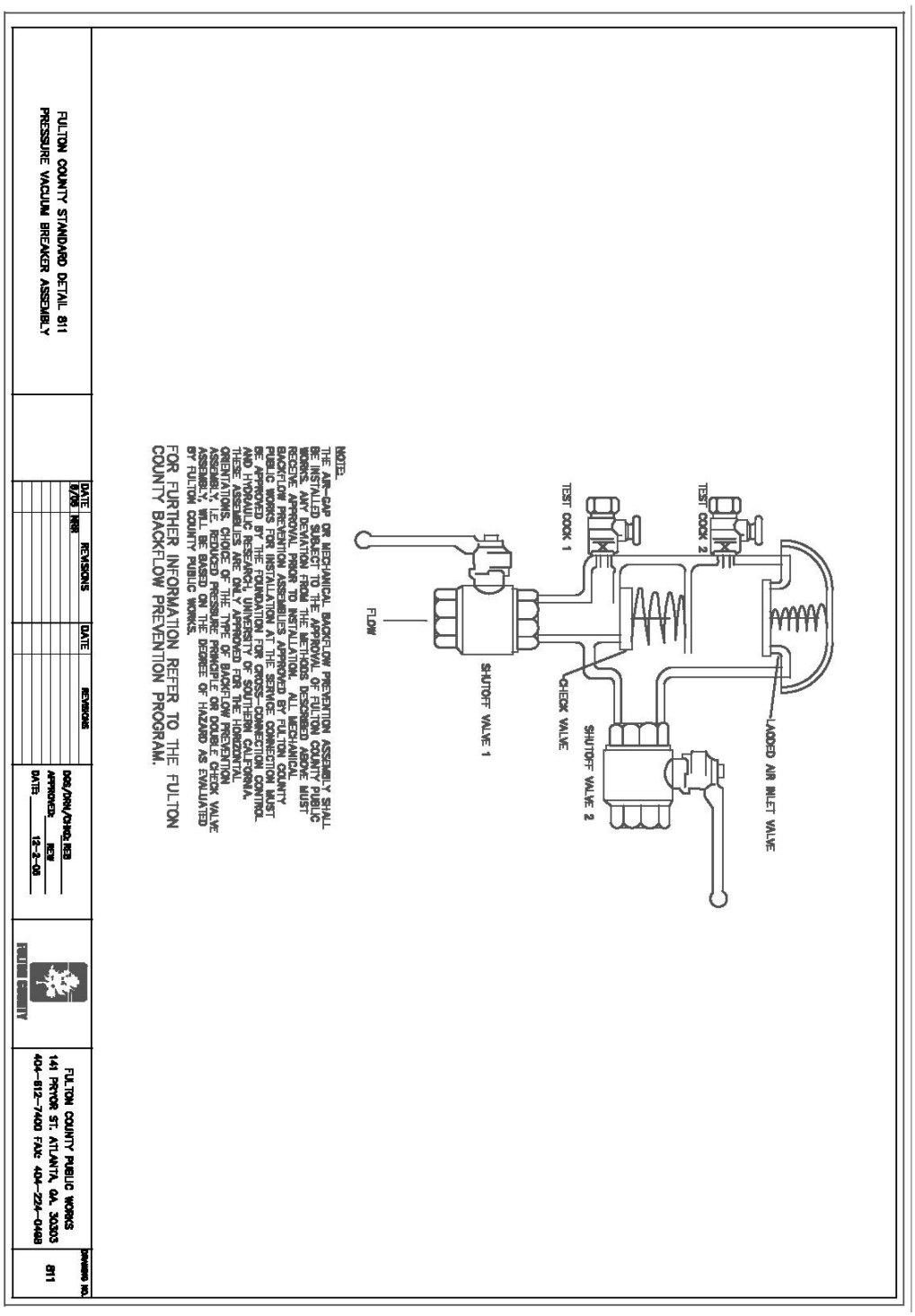
A DCVA MUST BE PROTECTED FROM FREEZING TEMPERATURES. FOR TEMPERATURES OF 100 DEGREES FAHRENHEIT (43 DEGREES CELSIUS) OR ABOVE, CONSULT MANUFACTURER'S LITERATURE FOR RECOMMENDATIONS.

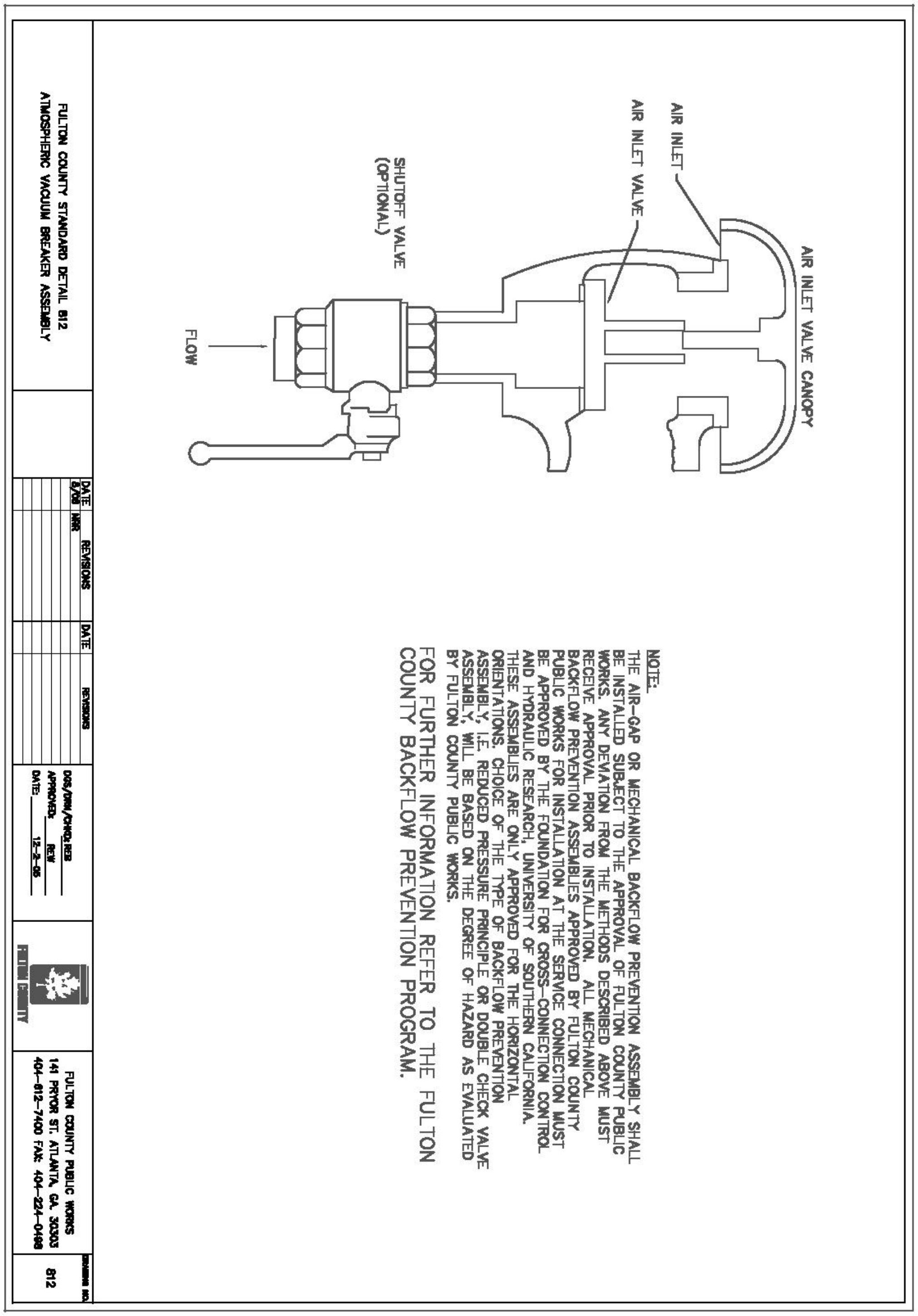


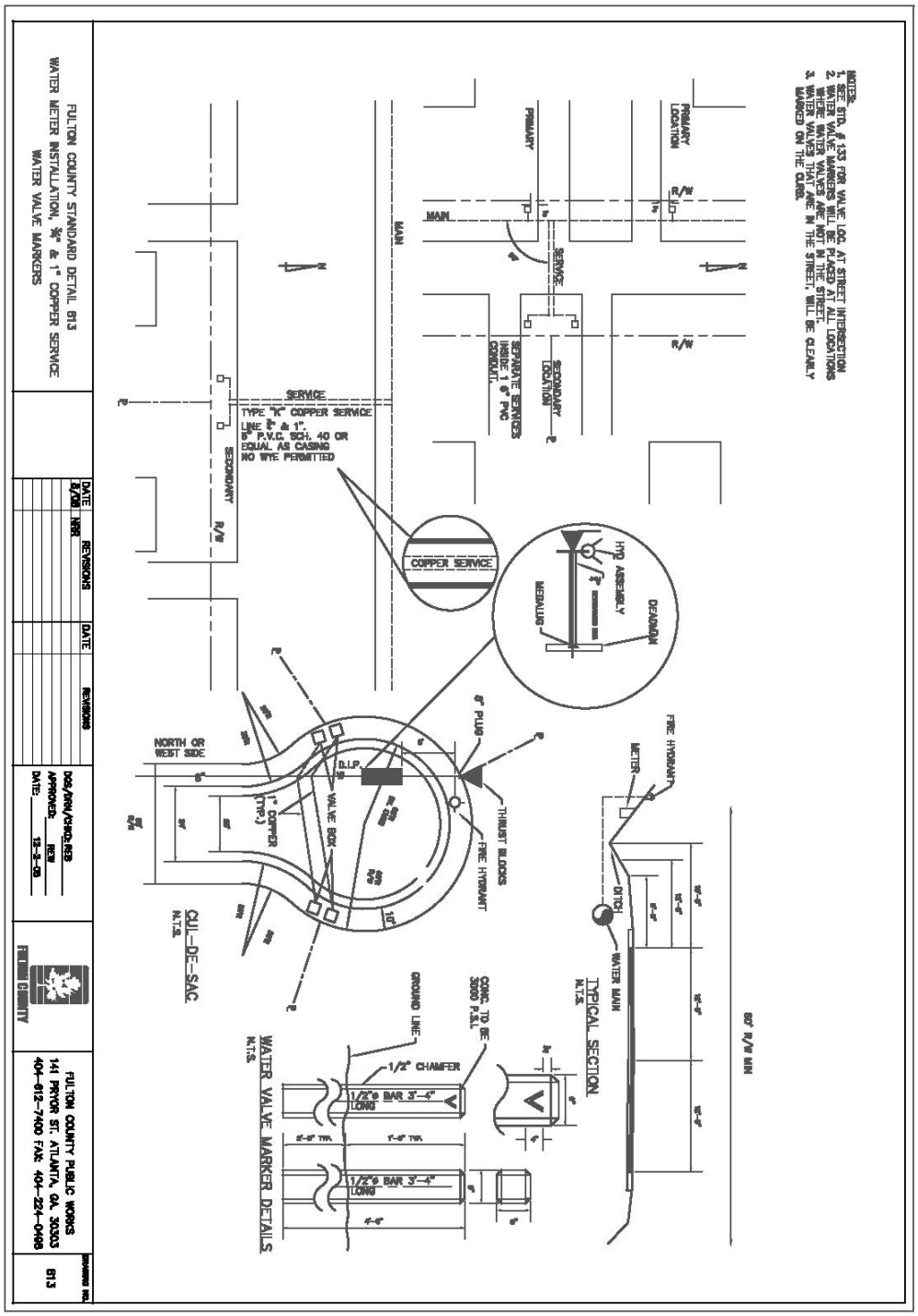
TYPICAL INSTALLATIONS WITH MINIMUM CLEARANCES
DOUBLE CHECK VALVE ASSEMBLIES

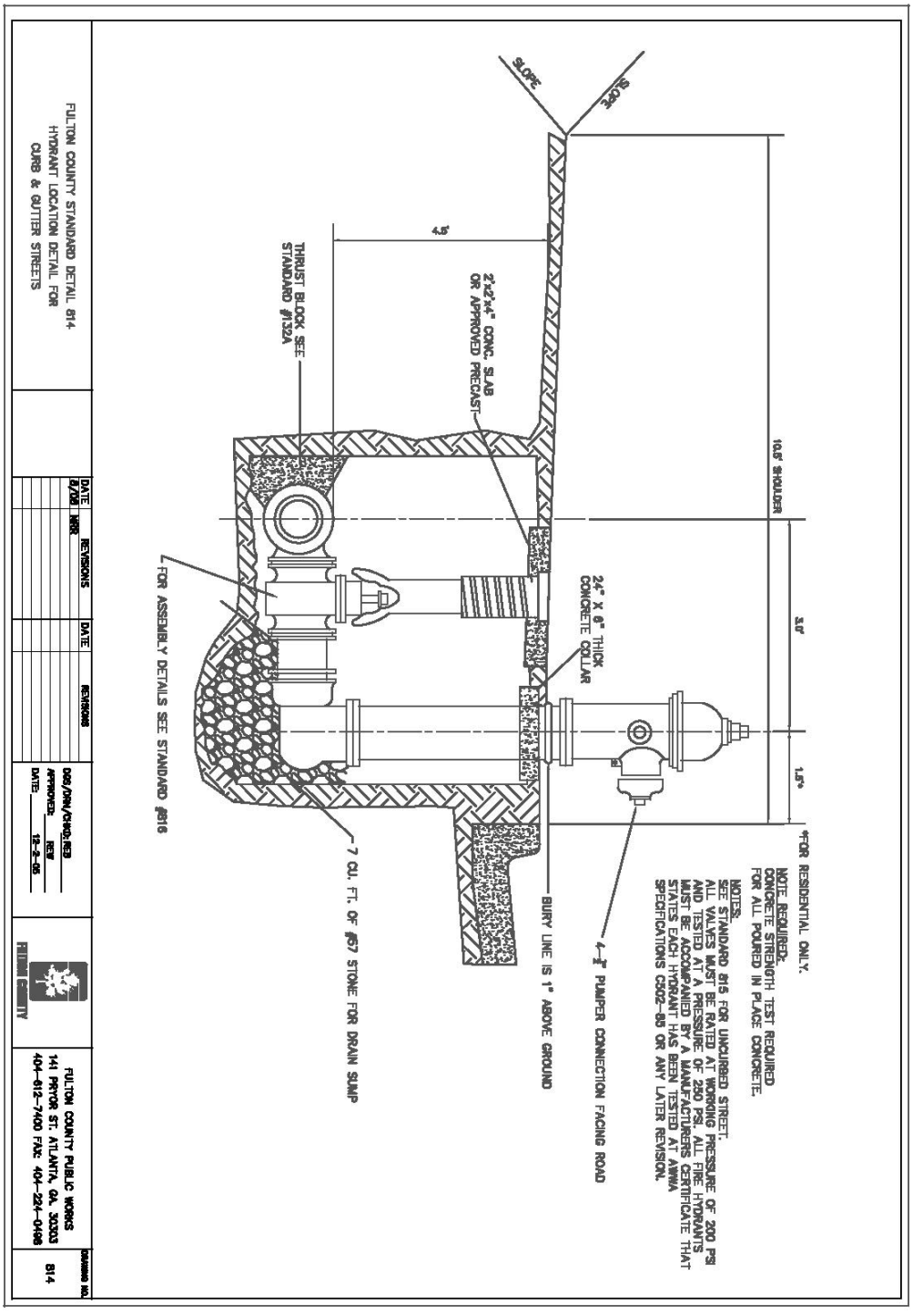
FULTON COUNTY STANDARD DETAIL 810 DOUBLE CHECK VALVE ASSEMBLY	DATE: 8/08	REVISIONS: NRR	DATE	REVISIONS	DGS/DRN/CHKD: CMS APPROVED: REW DATE: 12-2-05	FULTON COUNTY PUBLIC WORKS 141 PRYOR ST. ATLANTA, GA. 30303 404-612-7400 FAX: 404-224-0496

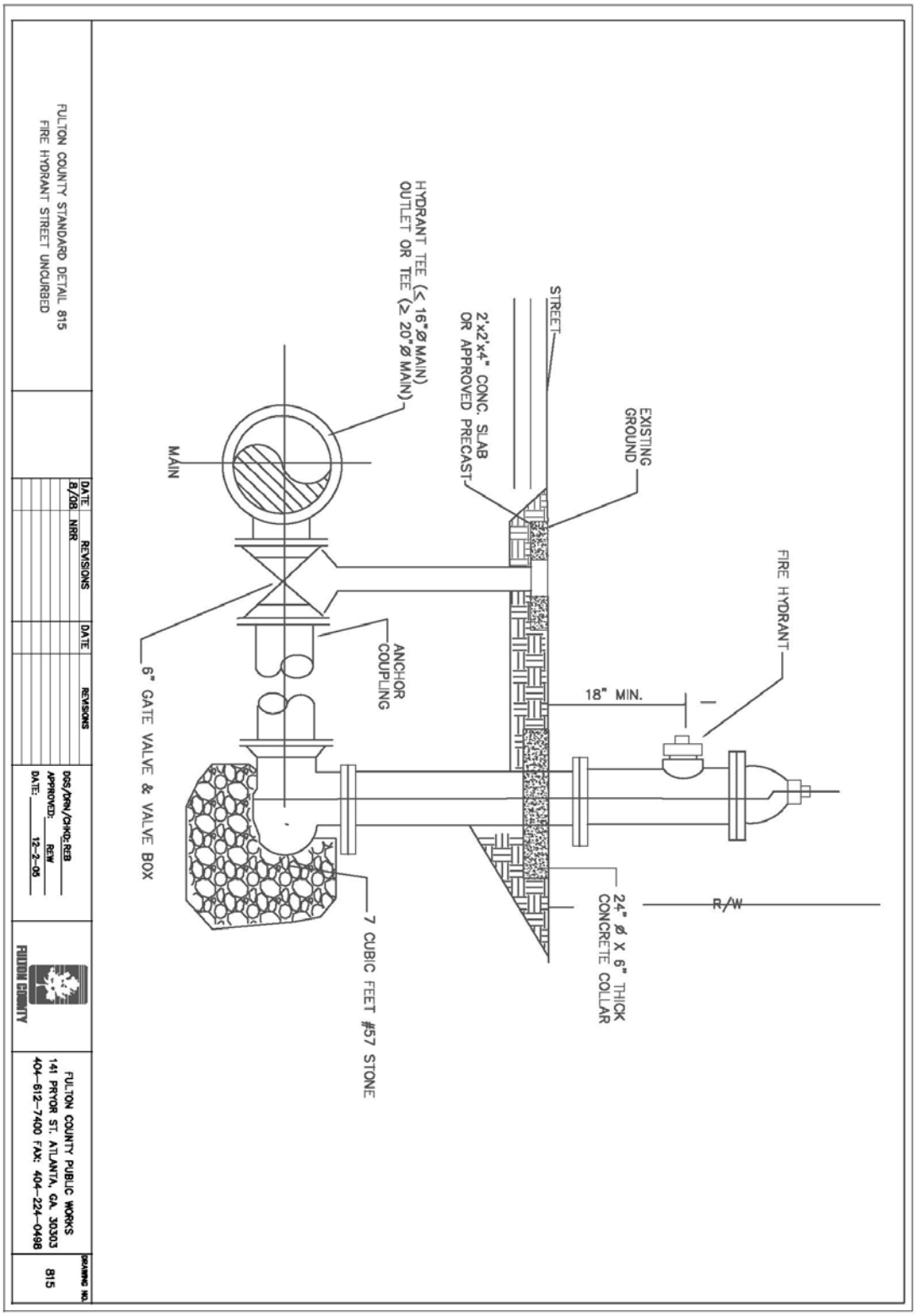
DRAWING NO. 810

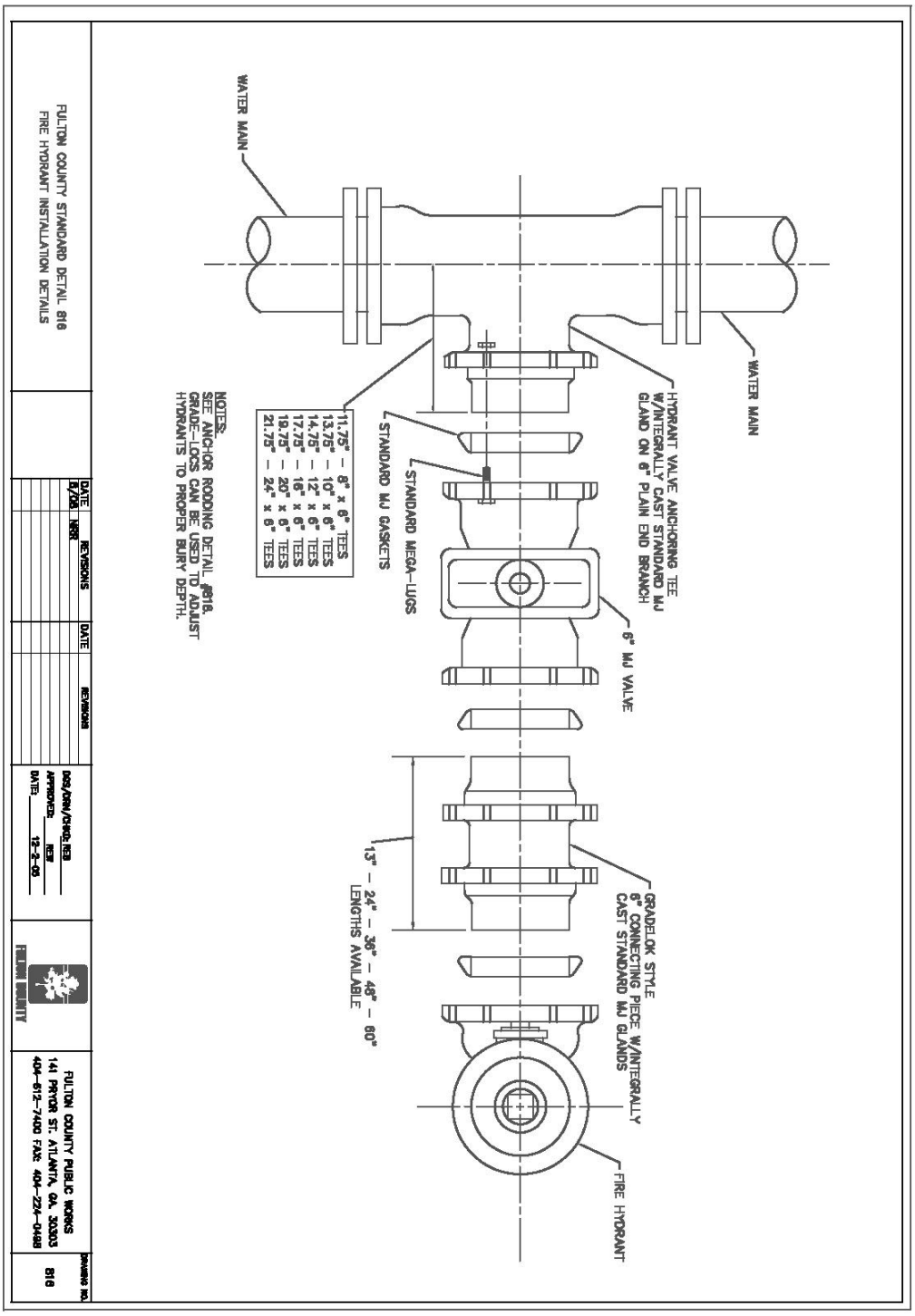

TEST COCK 2
TEST COCK 1
FLOW
SHUTOFF VALVE 1
CHECK VALVE
SHUTOFF VALVE 2
LARGED AIR INLET VALVE
NOTE:
THE AIR-GAP OR MECHANICAL BACKFLOW PREVENTION ASSEMBLY SHALL BE INSTALLED AS CLOSE AS PRACTICAL TO THE METER(S) SERVED. ANY DEVIATION FROM THE METHODS DESCRIBED ABOVE MUST RECEIVE APPROVAL PRIOR TO INSTALLATION. ALL MECHANICAL BACKFLOW PREVENTION ASSEMBLIES APPROVED BY FULTON COUNTY PUBLIC WORKS FOR INSTALLATION AT THE SERVICE CONNECTION MUST BE APPROVED BY THE FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH, UNIVERSITY OF SOUTHERN CALIFORNIA. THESE ASSEMBLIES ARE ONLY APPROVED FOR THE HORIZONTAL ORIENTATIONS. CHOICE OF THE TYPE OF BACKFLOW PREVENTION ASSEMBLY WILL BE BASED ON THE PRINCIPLE OR DOUBLE CHECK VALVE ASSEMBLY WILL BE BASED ON THE DEGREE OF HAZARD AS EVALUATED BY FULTON COUNTY PUBLIC WORKS.
FOR FURTHER INFORMATION REFER TO THE FULTON COUNTY BACKFLOW PREVENTION PROGRAM.
DATE
9/06
INK
REVISIONS
DATE
REVISIONS
DSG/DRN/CHKD.BY
APPROVED: RCW
DATE: 12-2-06
FULTON COUNTY
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0488
DRAWING NO.
811
FULTON COUNTY STANDARD DETAIL 811
PRESSURE VACUUM BREAKER ASSEMBLY

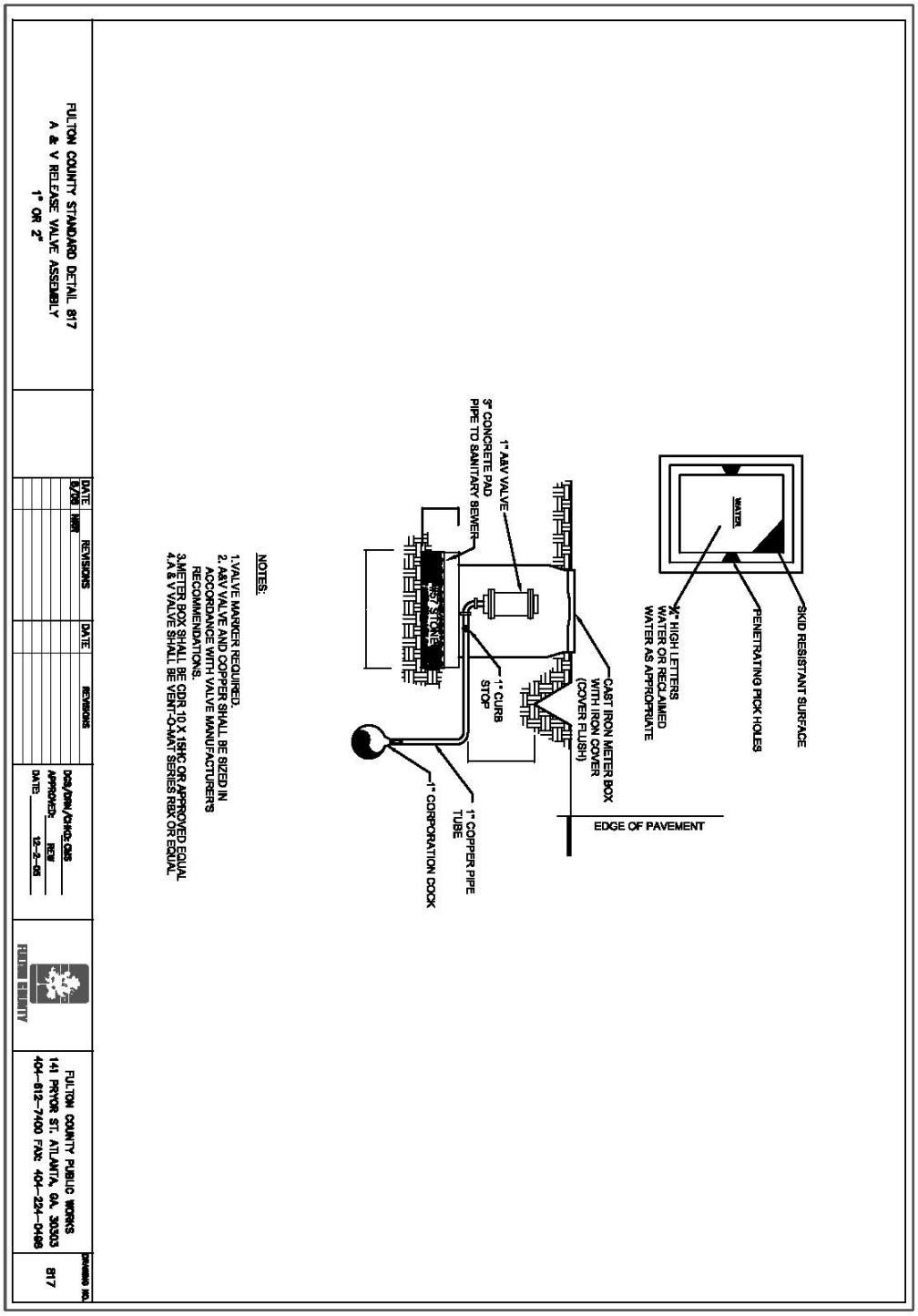

AIR INLET VALVE CANOPY
AIR INLET
AIR INLET VALVE
SHUTOFF VALVE (OPTIONAL)
FLOW
NOTE:
THE AIR-GAP OR MECHANICAL BACKFLOW PREVENTION ASSEMBLY SHALL BE INSTALLED SUBJECT TO THE APPROVAL OF FULTON COUNTY PUBLIC WORKS. ANY DEVIATION FROM THE METHODS DESCRIBED ABOVE MUST RECEIVE APPROVAL PRIOR TO INSTALLATION. ALL MECHANICAL BACKFLOW PREVENTION ASSEMBLIES APPROVED BY FULTON COUNTY PUBLIC WORKS FOR INSTALLATION AT THE SERVICE CONNECTION MUST BE APPROVED BY THE FOUNDATION FOR CROSS-CONNECTION CONTROL AND HYDRAULIC RESEARCH, UNIVERSITY OF SOUTHERN CALIFORNIA. THESE ASSEMBLIES ARE ONLY APPROVED FOR THE HORIZONTAL ORIENTATIONS. CHOICE OF THE TYPE OF BACKFLOW PREVENTION ASSEMBLY, I.E. REDUCED PRESSURE PRINCIPLE OR DOUBLE CHECK VALVE ASSEMBLY, WILL BE BASED ON THE DEGREE OF HAZARD AS EVALUATED BY FULTON COUNTY PUBLIC WORKS.
FOR FURTHER INFORMATION REFER TO THE FULTON COUNTY BACKFLOW PREVENTION PROGRAM.
FULTON COUNTY STANDARD DETAIL 812
ATMOSPHERIC VACUUM BREAKER ASSEMBLY
DATE
REVISIONS
DATE
REVISIONS
APPROVED:
DATE: 12-2-05
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0498
812

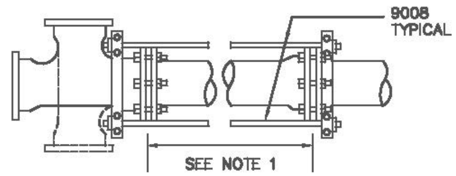

NOTES:
1. SEE STD. # 133 FOR VALVE LOC. AT STREET INTERSECTION
2. WHERE WATER VALVES ARE IN PAVED STREET, LOCATIONS
WHERE WATER VALVES ARE NOT IN THE STREET, WILL BE CLEARLY
3. WATER VALVES THAT ARE IN THE STREET, WILL BE CLEARLY
MARKED ON THE CURB.
PRIMARY LOCATION
MAIN
SERVICE
SECONDARY LOCATION
SEPARATE SERVICES INSIDE 1 6" PVC CONDUIT.
SERVICE
TYPE "K" COPPER SERVICE LINE 3/4" & 1". 6" P.V.C. SCH. 40 OR EQUAL AS CASING NO WYE PERMITTED
SECONDARY R/W
COPPER SERVICE
HYD ASSEMBLY
DEADMAN
MEDALLION
NORTH OR WEST SIDE
D.I.P.
6" PLUG
VALVE BOX
THRUST BLOCKS
FIRE HYDRANT
1" COPPER (TYP.)
CUL-DE-SAC
N.T.S.
FIRE HYDRANT METER
DITCH
WATER MAIN
TYPICAL SECTION
N.T.S.
60' R/W MIN
GROUND LINE
CONC. TO BE 3000 P.S.I.
1/2" CHAMFER
1/2"ø BAR 3'-4" LONG
1'-6" TYP.
WATER VALVE MARKER DETAILS
N.T.S.
FULTON COUNTY STANDARD DETAIL 613
WATER METER INSTALLATION, 3/4" & 1" COPPER SERVICE
WATER VALVE MARKERS
DATE: 8/08
REVISIONS
DES/DRN/CHKD: REB
APPROVED: REB
DATE: 12-2-08
FULTON COUNTY
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0498
613


SLOPE
3:1 OTS
10.5' SHOULDER
4.5'
2'x2'x4" CONC. SLAB OR APPROVED PRECAST
THRUST BLOCK SEE STANDARD #132A
24" X 6" THICK CONCRETE COLLAR
3.0'
1.5'*
*FOR RESIDENTIAL ONLY.
NOTE REQUIRED:
CONCRETE STRENGTH TEST REQUIRED FOR ALL POURED IN PLACE CONCRETE.
NOTES:
SEE STANDARD 815 FOR UNCURBED STREET.
ALL VALVES MUST BE RATED AT WORKING PRESSURE OF 200 PSI AND TESTED AT A PRESSURE OF 250 PSI. ALL FIRE HYDRANTS MUST BE ACCOMPANIED BY A MANUFACTURERS CERTIFICATE THAT STATES EACH HYDRANT HAS BEEN TESTED AT AWWA SPECIFICATIONS C502-85 OR ANY LATER REVISION.
4-2½" PUMPER CONNECTION FACING ROAD
BURY LINE IS 1' ABOVE GROUND
7 CU. FT. OF #57 STONE FOR DRAIN SUMP
FOR ASSEMBLY DETAILS SEE STANDARD #816
FULTON COUNTY STANDARD DETAIL 814
HYDRANT LOCATION DETAIL FOR CURB & GUTTER STREETS
DATE 8/08 BY MRR REVISIONS
DATE REVISIONS
DES/DRN/CHKD: RED
APPROVED: REW
DATE 12-2-05
FULTON COUNTY
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0498
DRAWING NO. 814

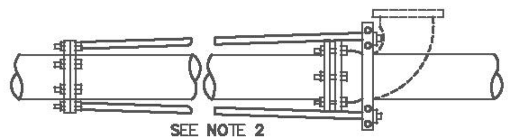

FULTON COUNTY STANDARD DETAIL 815
FIRE HYDRANT STREET UNCURBED
DATE
8/08
NRR
REVISIONS
DATE
REVISIONS
DGS/ARN/CHKD: REB
APPROVED: REW
DATE: 12-2-05
FULTON COUNTY
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA 30303
404-612-7400 FAX: 404-224-0498
DRAWING NO.
815
STREET
2'x2'x4" CONC. SLAB OR APPROVED PRECAST
EXISTING GROUND
FIRE HYDRANT
HYDRANT TEE (≤ 16"Ø MAIN) OUTLET OR TEE (≥ 20"Ø MAIN)
MAIN
18" MIN.
ANCHOR COUPLING
6" GATE VALVE & VALVE BOX
24" ø X 6" THICK CONCRETE COLLAR
R/W
7 CUBIC FEET #57 STONE


WATER MAIN
HYDRANT VALVE ANCHORING TEE W/INTEGRALLY CAST STANDARD MJ GLAND ON 6" PLAIN END BRANCH
WATER MAIN
STANDARD MJ GASKETS
STANDARD MEGA-LUGS
11.75" – 8" x 6" TEES
13.75" – 10" x 6" TEES
14.75" – 12" x 6" TEES
17.75" – 16" x 6" TEES
19.75" – 20" x 6" TEES
21.75" – 24" x 6" TEES
6" MJ VALVE
GRADELOK STYLE 6" CONNECTING PIECE W/INTEGRALLY CAST STANDARD MJ GLANDS
13" – 24" – 36" – 48" – 60" LENGTHS AVAILABLE
FIRE HYDRANT
NOTES:
SEE ANCHOR RODDING DETAIL #816.
GRADE-LOCS CAN BE USED TO ADJUST HYDRANTS TO PROPER BURY DEPTH.
FULTON COUNTY STANDARD DETAIL 816
FIRE HYDRANT INSTALLATION DETAILS
DATE
BY/DR
REVISIONS
DATE
REVISIONS
DES/DRN/CHKD: RB
APPROVED: RB
DATE: 12-2-09
FULTON COUNTY
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0488
DRAWING NO.
816


FULTON COUNTY STANDARD DETAIL 817
A & V RELEASE VALVE ASSEMBLY
1" OR 2"
DATE
REVISIONS
DATE
REVISIONS
DES/DRN/CHKD: CMS
APPROVED: REM
DATE: 12-2-08
FULTON COUNTY
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0486
DRAWING NO.
817
NOTES:
1.VALVE MARKER REQUIRED.
2. A&V VALVE AND COPPER SHALL BE SIZED IN ACCORDANCE WITH VALVE MANUFACTURER'S RECOMMENDATIONS.
3.METER BOX SHALL BE CDR 10 X 19HC OR APPROVED EQUAL
4.A & V VALVE SHALL BE VENT-O-MAT SERIES RBX OR EQUAL
WATER
SKID RESISTANT SURFACE
PENETRATING PICK HOLES
3/4" HIGH LETTERS WATER OR RECLAIMED WATER AS APPROPRIATE
CAST IRON METER BOX WITH IRON COVER (COVER FLUSH)
EDGE OF PAVEMENT
1" A&V VALVE
3" CONCRETE PAD
PIPE TO SANITARY SEWER
1" CURB STOP
1" COPPER PIPE TUBE
1" CORPORATION COCK



TEE ANCHOR
N.T.S.

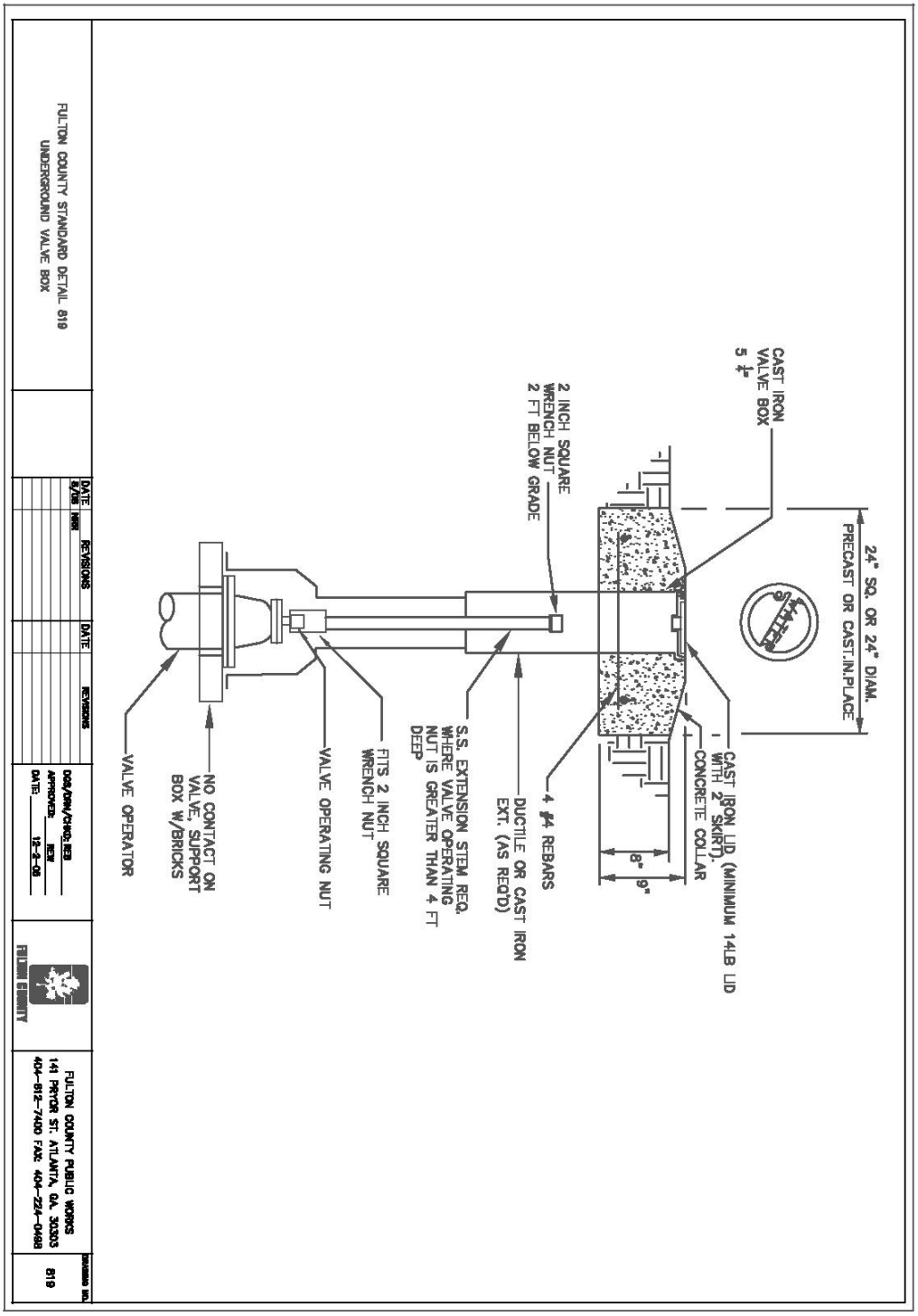


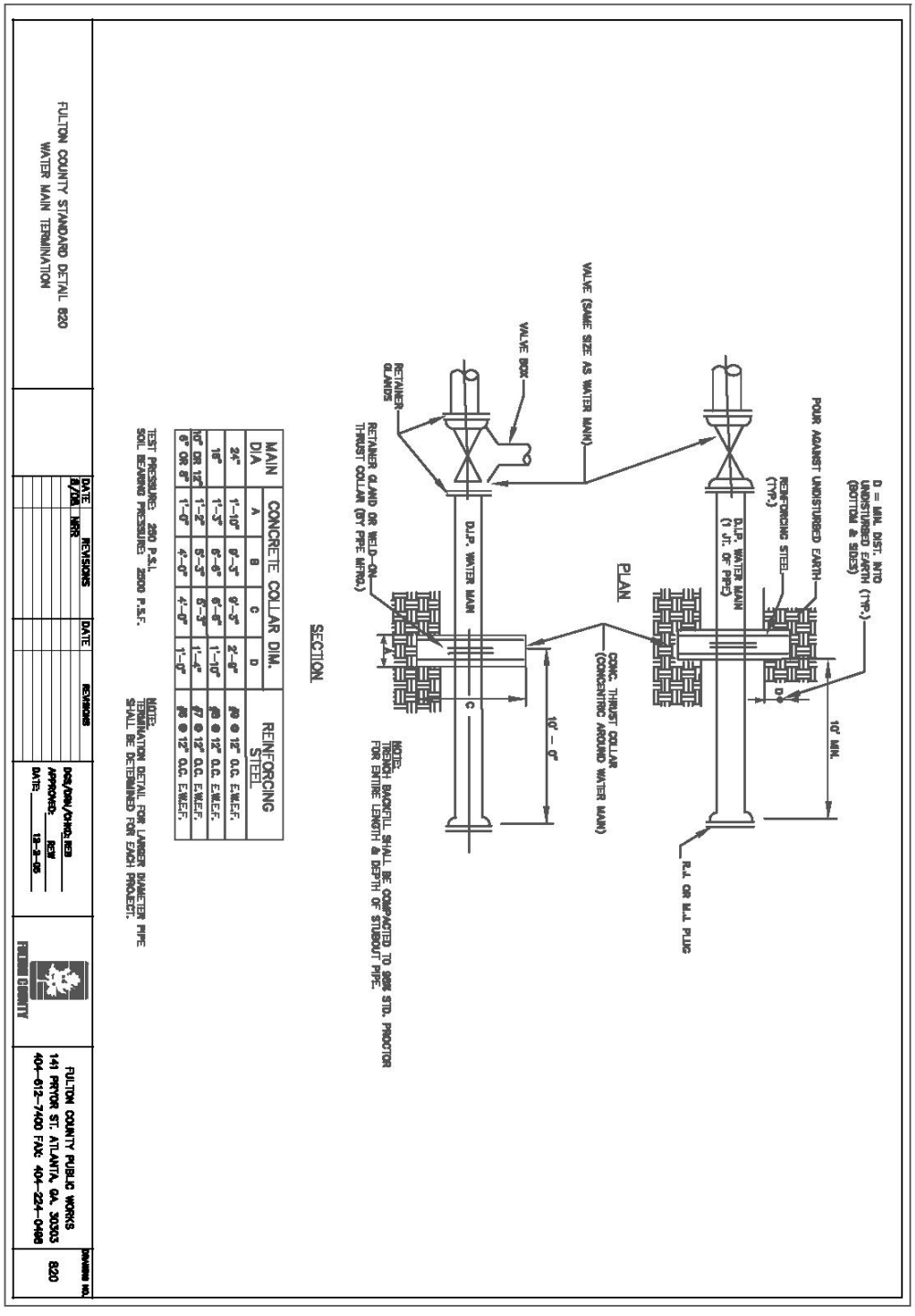
PIPE OR BEND ANCHOR TO FLANGE SPIGOT
N.T.S.

NOTES:

1. IN THE ASSEMBLIES OF RODS AND CLAMPS SHOWN, RODS RUN FROM A LUG ON THE FITTING (OR A CLAMP BEHIND THE HUB OF A BELL) TO A CLAMP AGAINST THE FACE OF A BELL. NOTE THAT THIS ARRANGEMENT ANCHORS ONLY ONE JOINT. THE STABILITY OF THE JOINT WHERE THE CLAMP IS AGAINST THE FACE OF THE BELL DEPENDS ON HAVING SOIL ABOVE A RELATIVELY LONG PIECE OF PIPE ON BOTH SIDES OF THE JOINT. CONSEQUENTLY, IF THE DISTANCE BETWEEN THE FIRST AND SECOND JOINT IS LESS THAN 12 FEET, THE SECOND JOINT SHOWN SHALL BE ANCHORED BY A CLAMP BEHIND THE HUB OF THE BELL AND RODS TO A CLAMP AT THE FACE OF THE NEXT BELL.
2. IN THE ASSEMBLIES SHOWN FOR RODS TO FLANGED FITTINGS, NOTE THAT THE FLANGED FITTING IS NOT TO BE BURIED IN SOIL.
3. AFTER INSTALLATION TIE RODS AND CLAMP ASSEMBLY SHALL BE THOROUGHLY COVERED WITH ROYSTON LABORATORIES INC. ROSKOTE MASTIC NO. A-938 OR KOPPERS CO INC. BITUMASTIC SUPERSERVICE BLACK OR APPROVED EQUIVALENT.
4. RODS TO BE HIGH TENSILE, HOT ROLLED STEEL WITH TENSILE STRENGTH OF 150,000 P.S.I. AND A MINIMUM YIELD STRENGTH OF 130,000 P.S.I.

FULTON COUNTY STANDARD DETAIL 818 TYPICAL ANCHORS		DATE / REVISIONS 8/08 NRR	DATE / REVISIONS	DGS/DRN/CHKD: REB APPROVED: REW DATE: 12-2-08	FULTON COUNTY	FULTON COUNTY PUBLIC WORKS 141 PRYOR ST. ATLANTA, GA. 30303 404-612-7400 FAX: 404-224-0498	DRAWING NO. 818


24" SQ. OR 24" DIAM.
PRECAST OR CAST-IN-PLACE
CAST IRON VALVE BOX 5 ft
2 INCH SQUARE WRENCH NUT 2 FT BELOW GRADE
CAST IRON LID (MINIMUM 14LB LID WITH 2" SKIRT).
CONCRETE COLLAR
8"
9"
4 #4 REBARS
DUCTILE OR CAST IRON EXT. (AS REQ'D)
S.S. EXTENSION STEM REQ. WHERE VALVE OPERATING NUT IS GREATER THAN 4 FT DEEP
FITS 2 INCH SQUARE WRENCH NUT
VALVE OPERATING NUT
NO CONTACT ON VALVE, SUPPORT BOX W/BRICKS
VALVE OPERATOR
FULTON COUNTY STANDARD DETAIL 819
UNDERGROUND VALVE BOX
DATE
REVISIONS
DATE
REVISIONS
DOS/DRW/CHKD: BEB
APPROVED: BEB
DATE: 12-2-08
FULTON COUNTY
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0498
819



MAIN DIA	CONCRETE COLLAR DIM.				REINFORCING STEEL
	A	B	C	D	
24"	1'-10"	6'-3"	6'-3"	2'-6"	#9 @ 12" O.C. E.W.E.F.
16"	1'-3"	6'-6"	6'-6"	1'-10"	#9 @ 12" O.C. E.W.E.F.
NOT OR 12"	1'-2"	6'-3"	6'-3"	1'-6"	#7 @ 12" O.C. E.W.E.F.
8" OR 6"	1'-0"	4'-0"	4'-0"	1'-0"	#5 @ 12" O.C. E.W.E.F.

TEST PRESSURE: 250 P.S.I.
SOIL BEARING PRESSURE: 2500 P.S.F.

NOTE: TERMINATION DETAIL FOR LARGER DIAMETER PIPE SHALL BE DETERMINED FOR EACH PROJECT.

FULTON COUNTY STANDARD DETAIL 820
WATER MAIN TERMINATION

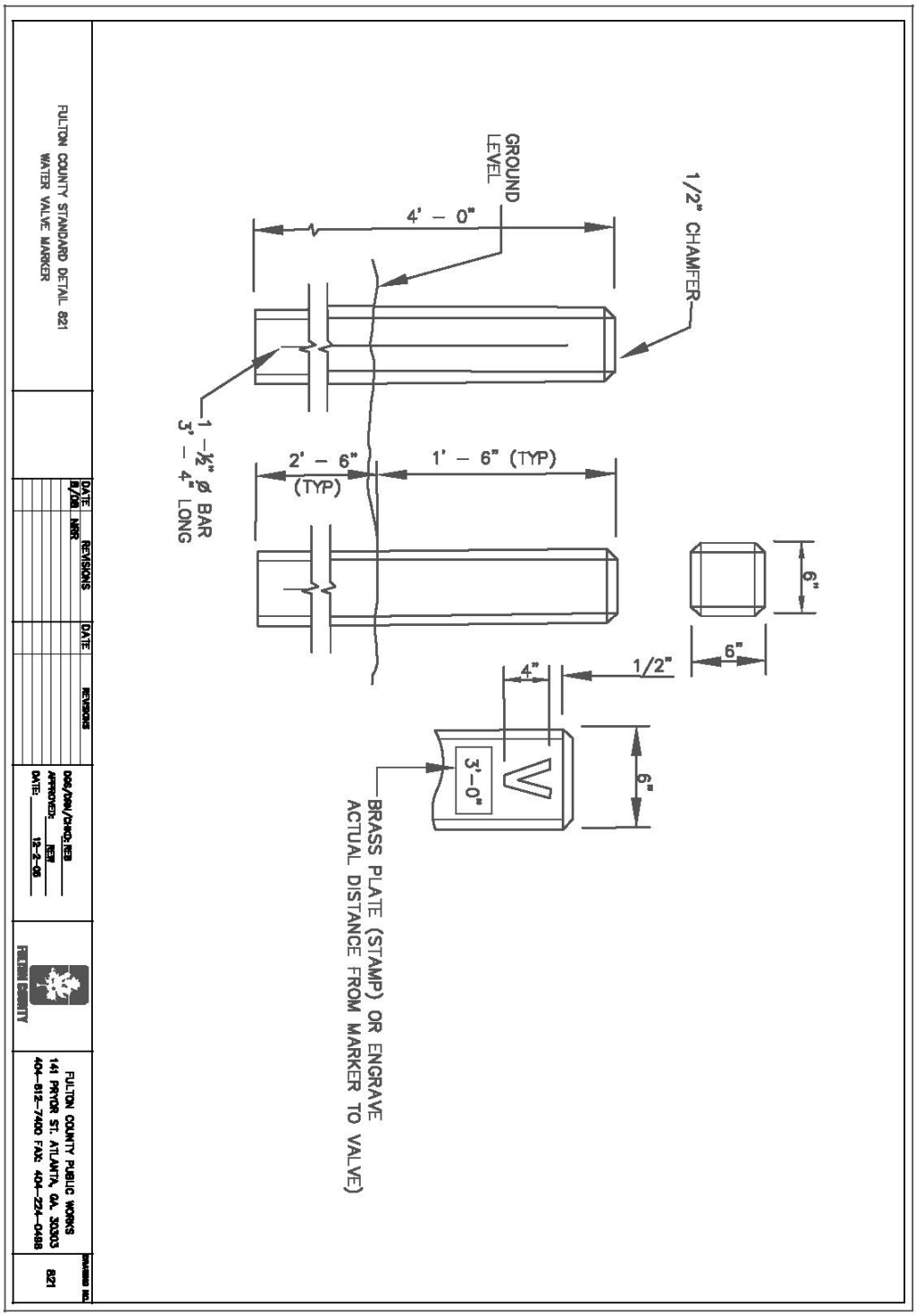
DATE	REVISIONS	DATE	REVISIONS
8/XX	MRR		

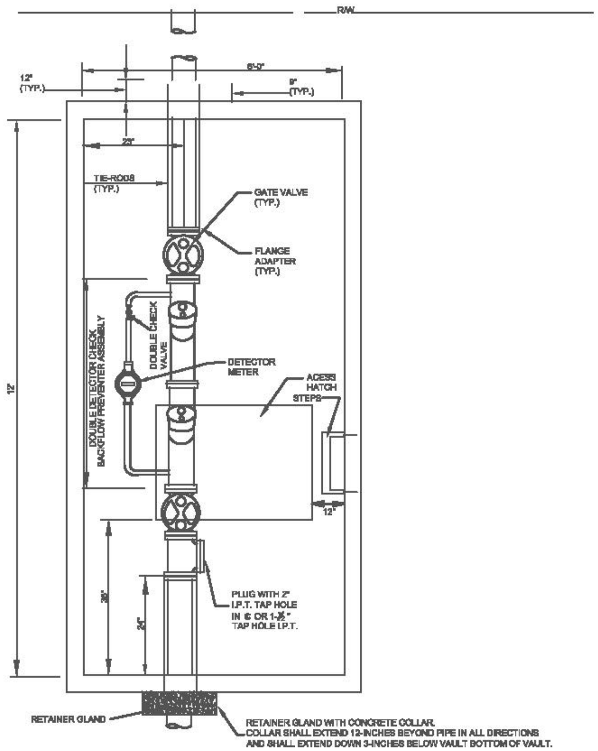
DSR/DBN/CHKD. BEB
APPROVED: REW
DATE: 12-9-05

FULTON COUNTY

FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0486

DRAWING NO. 820


GROUND LEVEL
4' – 0"
1/2" CHAMFER
1 – ½" ø BAR
3' – 4" LONG
2' – 6" (TYP)
1' – 6" (TYP)
6"
6"
4"
1/2"
3'-0"
6"
BRASS PLATE (STAMP) OR ENGRAVE
ACTUAL DISTANCE FROM MARKER TO VALVE)
FULTON COUNTY STANDARD DETAIL 821
WATER VALVE MARKER
DATE
REVISIONS
DATE
REVISIONS
DGN/DRW/SHEET.DGN
APPROVED: RER
DATE: 12-2-09
FULTON COUNTY
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0488
821



1. TYPE I VAULT SHALL BE USED FOR 3,4,6 OR 8-INCH DOUBLE DETECTOR CHECK BACKFLOW PREVENTER FOR USE WITH 1, 1-½ AND 2-INCH METER.
2. SEE SPECIFICATION SECTION 02665 FOR MATERIAL SPECIFICATIONS. ALL MATERIAL TO BE FURNISHED BY CONTRACTOR.
3. ALL FITTING SHALL BE DUCTILE IRON WITH FLANGED JOINTS. GATE VALVES SHALL BE OUTSIDE STEM AND YOKE (OSY) WITH HANDWHEEL.
4. VAULT SHALL BE PRECAST CONCRETE. MIN. INSIDE HEIGHT SHALL BE 6 FEET. LOAD BEARING VAULT SHALL BE DESIGNED BY PROPERTY OWNER'S ENGINEER, AND SUBMITTED TO COUNTY FOR APPROVAL.
5. ACCESS HATCH/FLOOR DOOR SHALL BE MIN. 36" X 36".
6. VAULT FLOOR SHALL BE # 57 CRUSHED STONE, MIN. 6-INCHES THICK.
7. PROVIDE CONCRETE PIER UNDER BFP 12" X 12" X 18" HIGH.
8. PROVIDE RETAINER GLAND ON PIPE BEYOND VAULT WALLS. PROVIDE TWO TIE RODS FROM FIRST INTERIOR FLANGE TO RETAINER GLANDS, WITH DOUBLE NUTS AND WASHERS. ENCASE RETAINER GLANDS IN CONCRETE. ALSO, PROVIDE TIE RODS FROM RETAINER GLAND TO TAPPING VALVE OR CASING UNDER ROAD, WHICH-EVER IS CLOSER. RODS SHALL BE PROVIDED WITH BITUMASTIC COATING.
9. VAULT WALL OPENINGS SHALL BE SEALED WITH NON-SHRINK GROUT. ENSURE 1-INCH CLEARANCE BETWEEN TOP OF PIPE AND PRECAST WALL.
10. MANHOLE STEPS SHALL BE DOWELLED INTO VAULT WALL AND CENTERED ON ACCESS HATCH.

FULTON COUNTY STANDARD DETAIL 822
FIRE LINE VAULT–TYPE I

DATE	REVISIONS	DATE	REVISIONS
8/08	NRR		

DGS/DRN/CHKD: REB
APPROVED: REW
DATE: 12-2-05

FULTON COUNTY

FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0496

DRAWING NO. 822

ASSUMPTIONS FOR STANDARD LENGTHS

PIPE: DUCTILE IRON, AWWA C-151
SOIL: GC & SC. CLAYEY GRAVELS, CLAYEY SANDS, GRAVEL-SAND-CLAY MIXTURES, SAND-CLAY MIXTURES.
AVERAGE DEPTH OF BURY: 4 FT
TRENCH TYPE: 4
TEST PRESSURE: 250 PSI
SAFETY FACTOR: 1.5:1 (BASED ON TEST PRESSURE)

NOTES:

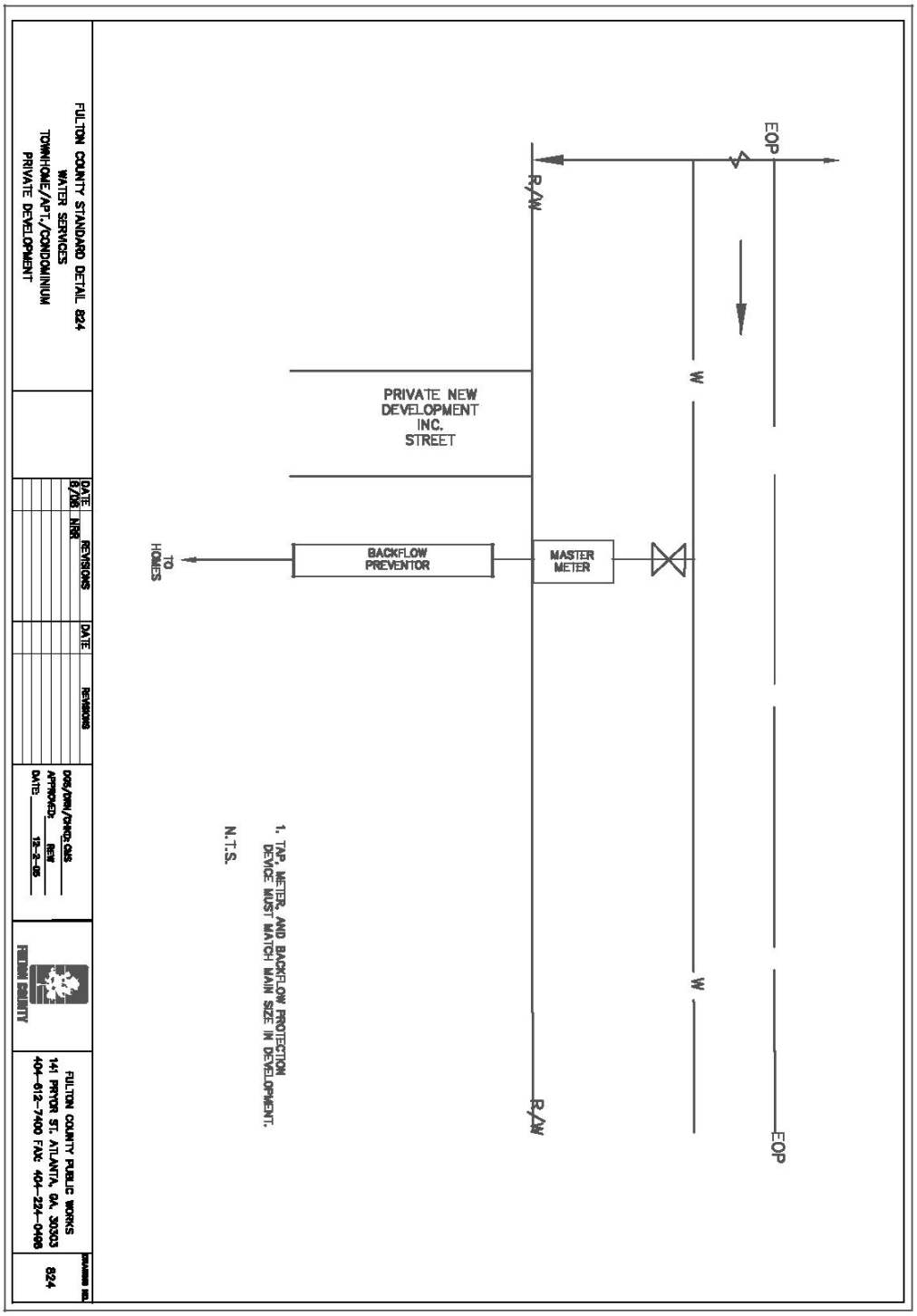
1. A FULL LENGTH OF PIPE ATTACHED TO EACH SIDE RUN OR BRANCH OUTLET SHALL BE INSTALLED, NO CUT OR PIECE OF PIPE SHALL BE USED.
2. WHERE FILL DIRT HAS BEEN ADDED TO SHOULDER, DEADMAN WILL BE INSTALLED 10 FT, FROM ANY BRANCH OUTLET OR END PIPE.
3. ALL JOINTS THAT FALL WITHIN THESE STANDARD LENGTH SHOULD BE RESTRAINED. (ON EACH SIDE OF BENDS ON THE BRANCH OUTLET OF TEES, AND BEFORE DEAD-ENDS).
4. STANDARD LENGTHS SHALL BE MODIFIED IF ACTUAL CONDITIONS DO NOT MEET MINIMUM REQUIREMENTS IN "ASSUMPTIONS FOR STANDARD LENGTHS".

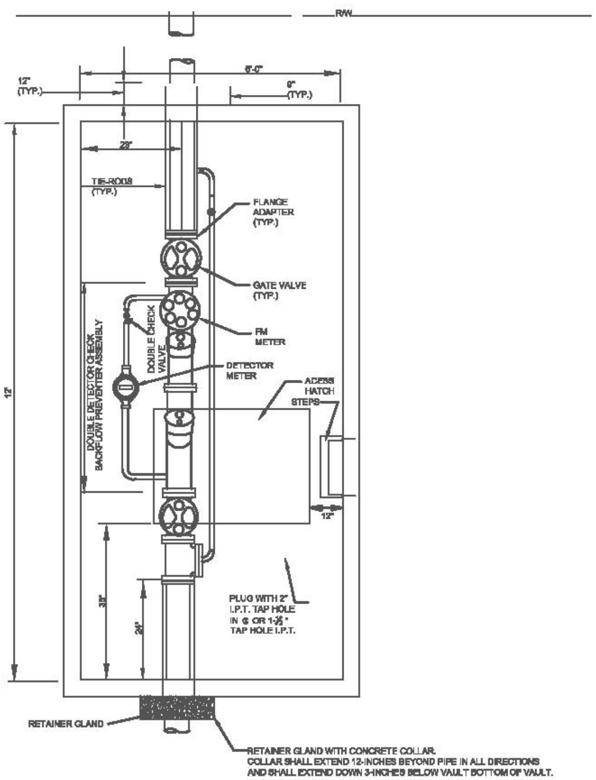
RECOMMENDED RESTRAINED LENGTHS OF DUCTILE IRON PIPE

NOM. PIPE SIZE (IN)	90 DEG. BEND	45 DEG. BEND	22.5 DEG. BEND	11.25 DEG. BEND	SIZE ON SIZE TEE*	VALVE/ DEAD-END
6	19 FT	8 FT	4 FT	2 FT	3 FT	35 FT
8	26 FT	11 FT	5 FT	3 FT	13 FT	46 FT
10	30 FT	13 FT	6 FT	3 FT	23 FT	56 FT
12	36 FT	15 FT	7 FT	4 FT	34 FT	67 FT
14	41 FT	17 FT	8 FT	4 FT	43 FT	77 FT
16	46 FT	19 FT	9 FT	5 FT	53 FT	87 FT
18	51 FT	21 FT	10 FT	5 FT	63 FT	96 FT
20	56 FT	23 FT	11 FT	6 FT	72 FT	106 FT
24	65 FT	27 FT	13 FT	7 FT	91 FT	126 FT

*RECOMMENDED RESTRAINED LENGTHS FOR TEES ARE FOR THE BRANCH OUTLET AND ASSUME A MINIMUM 10 FT. SECTION OF PIPE ATTACHED TO EACH SIDE OF THE RUN. RESTRAINT DEVICES SHOULD ALSO BE INSTALLED ON BOTH RUN JOINTS OF THE TEE ITSELF.

FULTON COUNTY STANDARD DETAIL 823 RESTRAINED JOINT PIPE STANDARD LENGTHS	DATE: 8/08	REVISIONS: NRR	DATE	REVISIONS	DGS/DRN/CHKD: REB APPROVED: REW DATE: 12-2-05	FULTON COUNTY	FULTON COUNTY PUBLIC WORKS 141 PRYOR ST. ATLANTA, GA. 30303 404-612-7400 FAX: 404-224-0498	DRAWING NO. 823


EOP
R/W
W
PRIVATE NEW
DEVELOPMENT
INC.
STREET
BACKFLOW
PREVENTOR
MASTER
METER
TO
HOMES
W
R/W
EOP
1. TAP, METER, AND BACKFLOW PROTECTION
DEVICE MUST MATCH MAIN SIZE IN DEVELOPMENT.
N.T.S.
FULTON COUNTY STANDARD DETAIL 824
WATER SERVICES
TOWNHOME/APT./CONDOMINIUM
PRIVATE DEVELOPMENT
DATE
REVISIONS
DATE
REVISIONS
DGS/DRM/CHKD.DMS
APPROVED: REW
DATE: 12-3-09
FULTON COUNTY
FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0408
824



1. TYPE I VAULT SHALL BE USED FOR 3,4,6 OR 8-INCH FM METER.
2. SEE SPECIFICATION SECTION 02665 FOR MATERIAL SPECIFICATIONS. ALL MATERIAL TO BE FURNISHED BY CONTRACTOR.
3. ALL FITTINGS SHALL BE DUCTILE IRON WITH FLANGED JOINTS. GATE VALVES SHALL BE WITH HANDWHEELS.
4. VAULT SHALL BE PRECAST CONCRETE. MIN. INSIDE HEIGHT SHALL BE 6 FEET. LOAD BEARING VAULT SHALL BE DESIGNED BY PROPERTY OWNER'S ENGINEER, AND SUBMITTED TO COUNTY FOR APPROVAL.
5. ACCESS HATCH/FLOOR DOOR SHALL BE MIN. 36"X36" (BILCO MODEL PCM-5) FOR 3 & 4-INCH METERS OR 54"X54" (BILCO MODEL PDCM-3) FOR 6 & 8-INCH METERS.
6. VAULT FLOOR SHALL BE # 57 CRUSHED STONE, MIN. 6-INCHES THICK.
7. PROVIDE RETAINER GLAND ON PIPE BEYOND VAULT WALLS. PROVIDE TWO TIE RODS FROM FIRST INTERIOR FLANGE TO RETAINER GLANDS, WITH DOUBLE NUTS AND WASHERS. ENCASE RETAINER GLANDS IN CONCRETE. ALSO, PROVIDE TIE RODS FROM RETAINER GLAND TO TAPPING VALVE OR CASING UNDER ROAD, WHICH-EVER IS CLOSER. RODS SHALL BE PROVIDED WITH BITUMASTIC COATING.
8. VAULT WALL OPENINGS SHALL BE SEALED WITH NON-SHRINK GROUT. ENSURE 1-INCH CLEARANCE BETWEEN TOP OF PIPE AND PRECAST WALL.
9. MANHOLE STEPS SHALL BE DOWELLED INTO VAULT WALL AND CENTERED ON ACCESS HATCH.

FM METER		
METER SIZE	6' & 8'	3' & 4'
VAULT INTERIOR DIMENSION	12' X 6'	9' X 5'

FULTON COUNTY STANDARD DETAIL 825
FM ASSEMBLY

DATE	REVISIONS	DATE	REVISIONS
8/08	NRR		

DGS/DRN/CHKD: CMS
APPROVED: REW
DATE: 3-7-08

FULTON COUNTY

FULTON COUNTY PUBLIC WORKS
141 PRYOR ST. ATLANTA, GA. 30303
404-612-7400 FAX: 404-224-0496

DRAWING NO. 825

Georgia Department of Transportation

State of Georgia

Special Provision

PROJECT NO.:

P.I. NO.:

Section 865—Manufacture of Prestressed Concrete Bridge Members

Delete Subsection 865.1 and substitute the following:

This section includes the following requirements for precast-prestressed concrete bridge members and piling using High Performance Portland cement concrete as shown in the Plans:

- Manufacturing
- Inspecting
- Testing
- Marking
- Painting
- Rubbing as specified
- Plant handling
- Storing
- Shipping

The term "precast-prestressed concrete" is referred to as "prestressed concrete" in the rest of this Section.

Add the following to Subsection 865.2:

Material	Section
Concrete, Class AAA HPC	500

Add the following to the end of Subsection 865.2.01.B.7.a.6:

Optional Method of Curing for Release Strengths with HPC: Temperature match curing ("Sure Cure" or equivalent methods) is allowed for specimens used to determine when stress may be transferred to the concrete for High Performance Concrete Units.

Section 936—Closed Circuit Television (CCTV)

936.1 General Description

This work includes furnishing and installing closed circuit television (CCTV) system, any specified type, which is a CCTV video surveillance camera, including but not limited to color CCTV cameras, lens, housing, pan/tilt drive, camera system assembly, cabling, mounting hardware, interface panel, camera control receiver, and cabinet wiring. This CCTV system includes both fixed and PTZ cameras as called for in the plans and provides operator control from and video imaging to the Department's NaviGAtor Advanced Transportation Management System (ATMS), or other camera operating software indicated on the plans or in the contract documents.

Provide all equipment, materials, and work in accordance with all manufacturers' recommendations, including but not limited to all mounting, wiring and cabling, power supply, surge suppression, and communications equipment and materials. Use only equipment and components that meet the requirements of these minimum specifications and are listed on the Department's Qualified Products List (QPL).

936.1.01 Definitions

CCTV System, Type B – The Type B PTZ Dome CCTV System uses a self-contained camera system assembly with an analog NTSC video output and RS-232 or RS-485 serial data control interface. This camera is used for, shall be compatible with the legacy NaviGAtor System, and should be used for additions/replacement within existing system segments.

CCTV Camera Type C – The Internet Protocol (IP) PTZ Dome Camera System (IP) camera uses a built in encoder to provide the Moving Picture Experts Group's MPEG4 part 10 (H.264) video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 14496-10:2009 standard. This camera is compatible with the legacy NaviGAtor System, but should be used for new installations in expansion segments.

CCTV Camera Type D – The Internet Protocol (IP) Fixed Camera System uses a built in encoder to provide the Moving Picture Experts Group's MPEG4 part 10 (H.264) video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 14496-10:2009 standard and is for locations where fixed views are desired

CCTV Camera Type H – The Internet Protocol (IP) High Definition Camera System uses a built in encoder to provide the Moving Picture Experts Group's MPEG4 part 10 (H.264) video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 14496-10:2009 standard and is compliant with SMPTE 296M Standard of 1280 x 720 pixel resolution and a 16:9 format. It is compatible with the NaviGAtor System, and provides enhanced features for digital zoom and new format displays (16:9) at viewing stations.

CCTV Camera Type N – The Internet Protocol (IP) PTZ Camera System for Night (low light) viewing may be provided in an outdoor external positioner or dome. Night vision will be provided by thermal imaging.

Video Encoder, Type B – Type B is a standalone, environmentally hardened encoder for a single video signal, suitable for field cabinet use and providing the Moving Picture Experts Group's MPEG4 part 10 (H.264) video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 14496-10:2009 standard.

Video Encoder, Type C –Type C is a high density unit that supports multiple video signals and is suitable for control center use and providing the Moving Picture Experts Group's MPEG4 part 10 (H.264) video compression technology in accordance with the International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) requirements detailed in the ISO/IEC 14496-10:2009 standard.

Video Encoder, Type D – This encoder is a standalone, environmentally hardened encoder for a single video signal, suitable for field cabinet use that is compatible with the existing legacy encoder and decoder video systems and otherwise would not meet Type B requirements.

Video Encoder, Type E – This encoder is a high density encoder card unit for multiple video signals, with one encoder per video signal, suitable for control center use with the existing legacy encoder and decoder video systems and otherwise would not meet Type B requirements.

Video Encoder, Chassis Type E –This chassis is a high density mount unit that supports multiple Video Encoder Type C or Video Decoder Type C cards suitable for control center use with the existing legacy encoder and decoder video systems.

936.1.02 Related References

A. Standard Specifications

Section 639 – Strain Poles for Overhead Sign and Signal Assemblies

Section 680 – Highway Lighting

Section 682 – Electrical Wire, Cable and Conduit

Section 922 – Electrical Wire and Cable

Section 923 – Electrical Conduit

Section 925 – Traffic Signal Equipment

Section 939 – Communication and Electronic Equipment

B. Referenced Documents

American National Standards Institute (ANSI)

American Society of Testing and Materials (ASTM)

Electronic Industries Association (EIA)

FCC Rules Part 15, Sub-part J

Insulated Cable Engineers Association (ICEA)

International Electrotechnical Commission (IEC) ISO/IEC 14496-10:2009

International Municipal Signal Association (IMSA)

MIL-HDBK-454A

MIL-STD-810F(3) Method 509 Procedure 1 – exterior salt atmospheres

National Electric Code (NEC)

National Electrical Manufacturers Association (NEMA)

NEMA-4

Underwriter's Laboratory Incorporated (UL)

National Television Standards Committee (NTSC)

936.1.03 Submittals

This subsection and the following chart provide the Contractor with an outline of the submittal requirements for the equipment and components for all pay items in this Section 936. This chart is to be used as a guide and does not relieve the Contractor from submitting additional information to form a complete submittal package.

Section 936 Submittal Requirements									
Material	**Specification Reference**	**Catalog Cuts**	**Mfg. Spec.**	**Materials Cert.**	**Lab Test**	**Install. Proced.**	**Test Plan**	**Maint. Proced.**	**Submittal Due Date (Cal. Days after NTP)**
Training Plan	936.3.08		X			X	X	X	60 Days

Submit test procedures required for this items within sixty (60) calendar days after the Notice to Proceed and prior to any installation, unless noted otherwise in the Contract Documents.

Submit to the Engineer for approval, two (2) printed and one (1) electronic copy of service and maintenance documentation for all equipment, components and all other materials required within these specifications.

Provide submittal data that is neat, legible, and orderly. Neatly organize each package of submittal data and separate by hardware item. Use the "Materials Certification Package Index and Transmittal Form", contained in Section 105.02 of the Special Provisions, for each pay item to document and list all material and components that are included in the submittal package. Any submittal data submitted without the Index/Transmittal form or that is incomplete will be rejected.

Products appearing on the Qualified Products List (QPL) are exempt from normal submittal requirements. These products have been evaluated by the Office of Traffic Operations and have proven their capability of meeting the appropriate Georgia Department of Transportation Specification. Any of these products may be used without submitting catalogue cuts, sampling or pre-testing. The Contractor shall submit a letter to the Engineer, stating which QPL items they will use. The Engineer and/or department designee must ascertain that the construction item is the same material identified on the appropriate QPL and will acknowledge receipt of these items in the project diary or as required by the Construction manual.

A. CCTV System; CCTV System, Retrofit Assembly; CCTV System, Retrofit Assembly (Furnish Only)

1. Camera System Assembly

   Submit complete physical, performance, and operational materials submittal data for the camera system assembly and all associated components.

2. Camera System Assembly Mount

   Submit complete physical, performance, and operational materials submittal data for the camera system assembly mount and all associated components and hardware.

3. Cabinet Interface Assembly

   Submit complete physical, performance, and operational materials submittal data for the cabinet interface assembly and all associated components and hardware. Submit complete physical, performance and operational materials, submittal data for all cables, wire and connectors required for a complete and operational CCTV system. Submit cables and connectors as specified here and as recommended by the CCTV system manufacturer.

4. Submittal Review Demonstration Test Set

   Submit demonstration test set(s) for Department evaluation after the Engineer approves the submittal materials for the equipment and materials listed below. The demonstration test sets shall be connected to and operated through the NaviGAtor system by the Engineer. Deliver the test set to the Department at the location specified by the Engineer. Request a delivery and test time a minimum of 30 days in advance. For projects with multiple camera installations, provide demonstration test sets of the materials, types and quantities as shown below:

   a. CCTV System (quantity 2)

   b. CCTV System, Retrofit Assembly (quantity 2)

      A demonstration test set shall include all materials, components, assemblies, control software an documentation of a CCTV system and shall be a complete, fully functional CCTV system.

B. Acceptance Testing

Submit acceptance test procedures and a desired acceptance test schedule.

C. Warranties and Guarantees

Submit materials submittal data providing complete example documentation on all manufacturers' warranties or guarantees on all CCTV system equipment and hardware components furnished, as required in Subsection 936.3.07.

D. Training

Prior to training, submit resume and references of instructor(s). Obtain approval from the Engineer that the instructor is qualified in his/her respective field. Submit the Training Plan within 120 days of the Notice to Proceed. Include in the training plan an outline of the training course. Obtain approval of the Training Plan from the Engineer. The Training Plan shall explain in detail the contents of the course and the time schedule of when the training shall be given. Coordinate actual training with installation schedules as approved by the Engineer.

936.2 Materials

936.2.01 CCTV Systems

Camera types are as specified on the plans, and may vary by location within project limits. Ensure that the individual components and assemblies of the CCTV System conform to the requirements specified in the following sections. Ensure that all equipment, materials, components and assemblies of the CCTV System conform to the CCTV manufacturer's requirements and recommendations.

A. Camera System Assembly

Follow these minimum requirements for a camera system assembly including the camera, dome assembly, lens, pan/tilt drive, and control electronics.

1. For dome enclosure cameras (Types B, C, and H)
   a. Provide a downward-looking circular dome-shaped enclosure assembly. The enclosure shall have a maximum diameter of 14 in (356 mm) at its widest point and a maximum height of 22 in (559 mm) from the top of the housing assembly to the bottom point of the dome. The upper housing shall be constructed of a non-metallic UV-stabilized material of a light color, or constructed of an aluminum material with a heat-cured paint coating of an equivalent color. The lower housing shall be constructed of a UV-stabilized optically-correct acrylic material. The maximum weight of the complete and fully functional camera system assembly, including the camera, lens, pan/tilt drive, control electronics, environmental control components, housing assembly, and hub adapter shall be 25 lbs (11.4 kg).

   b. Use an enclosure assembly that secures to the mounting bracket arm with a 1-1/2 in (37.5 mm) threaded pipe nipple. Hub adapters for the threaded pipe nipple on either the enclosure or the mounting arm, or both, are permitted.

   c. All fastening and mounting hardware on or within the enclosure assembly shall be stainless steel.

   d. Use a pressurized enclosure assembly that uses extra dry nitrogen. Provide a pressure relief valve and a Schrader valve for filling and evacuating the enclosure. The enclosure should have an operating pressure range of 3-7 psi (21-48 kPa).

   e. When an enclosure assembly requires a heater and a circulating blower fan for environmental (temperature and defogging) control, maximum electrical load for the heater shall be no more than 85 VA.

   f. Ensure that the CCTV camera system performs all required functions during and after being subjected to an ambient operating temperature range of -30º to 165º F (-34° to 74° C) as defined in the environmental requirements section of the NEMA TS 2 standard. Verify that the CCTV camera manufacturer certifies its device has successfully completed environmental testing as defined in the environmental requirements section of the NEMA TS 2 standard.

   g. Ensure that the housing protects the camera and other internal components from rain, dust, corrosive elements, and typical conditions found at a roadside environment. Ensure that the CCTV camera, mounting hardware, and any other camera-related material that is exposed to the environment can withstand 90 mph (145 kph) wind speeds.

   h. Electrical power for the complete camera system assembly shall be per the manufacturer's recommendations and between 12V to 120V DC or single-phase AC utilizing a two-wire (not counting ground) supply from the cabinet interface assembly in the equipment cabinet. Do not use a dual-voltage power supply. Maximum electrical load with all subsystems operational, including the heater, shall be no more than 130 VA.

   i. For analog cameras (Type B), ensure that the camera produces an analog NTSC-compliant composite video output with a signal-to-noise ratio of 45dB or greater.

   j. Use a camera unit with an integrated camera sensor and zoom lens assembly. The camera shall use a CCD image sensor, with a minimum of 768 horizontal by 492 vertical active picture elements. The camera shall have a minimum resolution of 460 horizontal TV lines by 350 vertical TV lines.

k. The camera shall include on/off selectable automatic gain control and manual/automatic selectable white balance. The camera shall include an electronic shutter mode with user-selectable speeds of a minimum range from 1/60 second to 1/10,000 second. The camera unit shall provide an on/off selectable day/night function where the image sensing and output automatically switch between color and black-and-white imaging; fixed color or black-and-white imaging shall be user-controllable. The camera sensitivity shall be no less than 3.0 lux in color mode (1/60 second) and 0.5 lux in black-and-white mode (1/60 second, IR cut removed).

l. Provide a camera unit with an integrated zoom lens of a minimum of 22X optical zoom and a minimum of 4X (HD Camera Type D shall have a minimum of 12X) digital zoom. The camera shall not employ any digital zoom functionality unless the lens is at the full limit of optical zoom and the zoom command continues to be applied, in which case the camera unit shall automatically switch from optical to digital zoom. The camera unit shall include on/off selectable automatic focus and manual/automatic selectable iris control.

m. Use a pan/tilt drive for the camera unit that is fully-contained within the enclosure assembly. The drive shall be capable of 360 degree panning and at least 0 degree horizontal to 90 degree vertical looking downward tilting. The camera unit and pan/tilt drive shall provide automatic 180-degree image output flip at the bottom of the tilt travel. The camera unit and pan/tilt drive shall provide a minimum of eight privacy blackout zones, each zone being individually programmable to be on/off by the user. The panning speed, when a pan-left or pan-right command is applied by the user, shall be between 10 and 18 degrees per second. The tilting speed, when a tilt-up or tilt-down command is applied by the user, shall be between 4 and 10 degrees per second.

n. Provide a system control interface to the camera system assembly that physically and logically supplies the user commands to and monitoring from the camera system assembly, including but not limited to pan, tilt, zoom, focus, position reporting, and configuration. The system control interface shall physically connect the camera system assembly to the cabinet interface. Provide a system control interface that is in compliance with all of the physical and operational requirements specified for a CCTV System. Provide the capability to set the communications through the system control interface or through the user control interface in the cabinet; do not require the opening/disassembly of the camera system enclosure to set the communications address. Store all user configurable settings in non-volatile memory that is retained indefinitely upon loss of power.

2. Camera Type D – Fixed Camera. Fixed cameras shall be designed for outdoor applications meeting NEMA 4X or IP-66 rating requirements and include all necessary harness and cables to extend the video, power and data from the CCTV Camera location to the field cabinet. The enclosure shall be suitable for the location and meet all requirements as denoted above for other camera types. The lens shall have a minimum F-stop of 1.4 with a variable manual zoom of 5 – 50 mm. The iris shall support automatic or set to yield optical results under various outdoor lighting conditions. The camera shall provide all other functionality as required of other types to produce a fixed view of the roadway.
3. IP Cameras (Types Cand D) shall provide the same functionality as the analog camera unit, and shall include built in integral encoders.(i.e., Ethernet ready). In addition, IP cameras shall meet the following minimum requirements:
   a. Power over Ethernet (IEEE802.3af) or 24 VAC power input.

   b. The integral video encoder in the dome assembly shall meet the exact same requirements for Video Encoder Type B, except that mounting/packaging, cable connectors, and power supply requirements shall be according to the camera manufacturer requirements. A serial console interface to the integral encoder is not required.

   c.

4. High Definition Cameras (Type H) shall provide the same functionality as other IP (built in encoders) camera types, and in addition, shall meet the following minimum requirements:
   a. HD 1080p resolution at 30 images per second (ips)

   b. Minimum 12x digital zoom.

   c. 16:9 aspect ratio

   d. Digital image stabilization

5. CCTV Camera Type N – Internet Protocol (IP) PTZ Camera System for Night (low light) viewing shall provide video surveillance imaging for reliable video images clearly in near total darkness. Images shall be provided in 640 X 480 resolution with dual output stream digital video in H.264, MPEG-4, or M-JPEG formats.

936.2.02 Camera System Assembly Mount

Provide a camera system assembly mount that includes a mounting bracket arm, camera enclosure mount and disconnect, mounting straps, and incidental fastening hardware. All fastening and mounting hardware shall be stainless steel.

The mounting bracket arm shall be suitable for pole-mounted applications using mounting straps or bolts. The bracket shall be fabricated to exactly mate with the camera enclosure mount/disconnect/pipe nipple and any needed pole-mount adapter with no drilling or welding required. The bracket shall be fabricated from aluminum alloy with an exterior polyurethane coating, stainless steel, or mild steel with a heat-cured paint coating. All bracket coatings shall be light in color and corrosion resistant in accordance with MIL-STD-810F (3) Method 509 Procedure 1 for exterior salt atmospheres.

Unless otherwise indicated on the plans, use a mounting bracket arm that locates the vertical centerline of the camera enclosure from 14 in (356 mm) to 24 in (610 mm) from the exterior surface of the support pole. The mounting bracket arm shall provide for cable entrance through the base of the bracket directly from the support pole and from the exterior through a rain tight opening on the underside of the bracket and adjacent to the support pole. The bracket arm shall provide sufficient opening to fully enclose the cables. Provide non-metallic cable protection grommets for both cable entrances. Unless otherwise shown in the Plans, mount the bracket arm to the support pole using a minimum of two ½ in (12.5 mm) or greater stainless steel mounting straps.

936.2.03 Camera Lowering System Assembly Mount

Where specified on the plans, provide a camera lowering system that includes a mounting bracket arm, self aligning docking system, video and power surge protection. The unit will be self contained, suitable for pole-mounted applications using straps or bolts. All fastening and mounting hardware shall be stainless steel. The lowering cable(s) shall be stainless steel. All bracket coatings shall be light in color and corrosion resistant in accordance with MIL-STD-810F (3) Method 509 Procedure 1 for exterior salt atmospheres. The lowering device shall have a support capacity of 55 lbs. (25 Kg.), and shall provide for camera systems at varying heights above ground level to match the height of the mounting structure. Electrical power for the complete camera lowering system assembly shall be per the manufacturer's recommendations and 120 VAC.

936.2.04 Cabinet Interface Assembly

Use a cabinet interface assembly that provides electrical service for the camera system assembly and provides the user control interface connection to the NaviGAtor system and/or user personnel. Install the cabinet interface assembly in the equipment cabinet. All fastening and mounting hardware shall be stainless steel. The cabinet interface panel assembly includes the following:

- CCTV Interface Enclosure
- Camera System Assembly Power Supply with surge suppression
- Terminal blocks and video cable surge suppression for camera system assembly cabling
- User control interface to the NaviGAtor system and/or user personnel with surge suppression

The NaviGAtor Standard CCTV Control Protocol (hereinafter called the "CCTV Standard Protocol") is specified below and shall connect to the user control interface unit through an RS-232 serial data interface directly from the NaviGAtor system. Provide the control software with an unrestricted, non-cancelable user license for the Department's use with any NaviGAtor equipment at any location. Furnish three (3) copies each of the software, license, appropriate RS-232 cable, and user documentation per project.

A. CCTV Standard Protocol

1. General

   For all camera types, use the NaviGAtor Standard CCTV Control Protocol (hereinafter called the "CCTV standard protocol" or "standard protocol") for CCTV system control communications between the camera unit and the GDOT NaviGAtor central system to achieve a fully functional communications interface to utilize all of the capabilities and functions of the camera. Implement the standard protocol for all CCTV equipment installed on this project. The CCTV standard protocol governs all control communications between the NaviGAtor central system (hereinafter called the "host") and the CCTV system.

2. Interface

   For Type B cameras, the CCTV System (hereinafter called the “remote”) shall communicate using the CCTV standard protocol over an RS-232 serial interface. Data is transmitted using 1 start bit, 8 data bits, and 1 stop bit (no parity) at a baud rate of 9600.

   Each remote shall be identified by a unique integer address between 1 and 233. This address is set during installation and shall not be altered using the standard protocol. The address is included in messages to identify the intended recipient of commands from the host and responses from the remote.

936.2.05 Cabling and Connectors

Provide cabling and connectors between the camera system assembly and the cabinet interface assembly as shown in the CCTV system detail drawings and in the Plans. Label all cables. All cables shall meet industry and manufacturer recommendations.

When required for the camera application, coaxial video signal cables will be provided with labels attached at both ends of each cable. Coaxial cables will use BNC connectors with gold-plated center pins on the video signal cables; use only connectors recommended by the cable manufacturer.

Provide control cable with labels attached at both ends of the cable. Terminate control cable in the equipment cabinet as shown in the CCTV system detail drawings in the plans and as recommended by the CCTV system manufacturer. Ground or bond any pair shielding and any unused conductors in accordance with the CCTV system manufacturer’s recommendations.

For IP Cameras, provide communications cabling (Outside Plant Category 5) as recommended by the CCTV system manufacturer. Label all cables. Separate power cables must be clearly labeled as such and meet manufacturer recommendations. When Power over Ethernet cameras are provided, cabling must be sized and rated in accordance with manufacturer recommendations and clearly labeled as such.

936.2.06 Video Encoder (All Types)

Provide a Video Encoder in accordance with the minimum requirements below for the encoding of analog video inputs and transmission as digital streams over a network.

A. Video Encoder, Type A

Not Used

B. Video Encoder, Type B

Video Encoder, Type B is a standalone, environmentally hardened encoder for a single video signal, suitable for field cabinet use.

1. General
   a. All encoders provided by the Contractor shall be new and shall be from the same manufacturer and be fully compatible and interoperable with each type provided.

   b. All encoder types provided by the Contractor shall be fully compatible and interoperable with the GDOT existing network equipment.

   c. Mean Time Between Failures (MTBF): Encoders shall have a minimum MTBF of 20,000 hours.

   d. Latency: The end-to-end system latency between the Encoder and Decoder appliances shall be no more than 300 msec, not including network delays. The encoders shall support various frame adjustments to minimize latency.

   e. Remote Control: Encoders shall be remotely adjustable via a video management system or command set so that a technician can adjust image quality controls for contrast, brightness, hue and color levels.

   f. Video equipment shall support the NTSC signal format.

   g. Furnish rack-mountable or shelf-mountable units.

   h. Rack-mountable units shall include integrated brackets for mounting in standard EIA 19-inch rack rack-mountings.

2. Physical and Environmental Requirements.
   a. The Video Encoder shall have the following ports as a minimum:
      - Network: 10/100 Mbps RJ-45 or as directed by Engineer.
      - Video Connector: BNC
      - Serial Data Interface: One (1) minimum RJ-45 port/connector.
      - Serial port may utilize D-sub connectors or terminal block connections as approved by the Engineer.

   b. In locations where there are more than one video source, and Encoders with multiple video ports are approved by Engineer, each video input port shall meet all the video and data requirements of Video Encoder Type B independently.

   c. The video input performance measures shall comply with NTSC and EIA requirements, including the EIA-170 standard, with a nominal composite video of 1 volt peak-to-peak (Vp-p). The equipment shall have an electrical impedance of 75 ohms.

   d. Operating temperature of -30 degrees F (-34 C) to 165 degrees F (74 C) with relative humidity between 10% to 90% non-condensing.

   e. Ventilation fans are not permitted.

   f. Encoders shall be installed in a field cabinet with protection from moisture and airborne contaminants, blowing rain, wind, blowing sand, blowing dust, humidity, roadside pollutants, vandalism, and theft.

   g. Encoders shall be resistant to vibration and shock, and conform to Sections 2.1.9 and 2.1.10, respectively, of the NEMA TS 2 standard.

   h. Encoders for field site locations shall be PCB conformal coated to provide a level of protection from humidity, contaminants, dust, pollution, etc.

   i. Encoders shall provide LED status indicators for local status display analog of video input, serial data interface activity, network interface activity and power.

   j. Cable connections (data/video/power) shall require no tools for installation or removal and be designed with positive locking devices such that they will not vibrate loose.

   k. Provide external markings for all connectors and indicators. Replaceable components shall be permanently marked and traceable to the supplied documentation, including schematics and parts list.

   l. The external markings shall include the product function name, model number, serial number, and manufacturer’s name.

   m. All parts required for a completed video system shall be made of corrosion-resistant materials, such as stainless steel, anodized aluminum, brass, or gold-plated metal.

   n. All individual Encoders shall be shelf, rack (19”)/module, or DIN rail mountable. Other mounting options may be submitted for review and approval by the Engineer.

   o. Nominal power input voltage of 120 VAC, 60 Hz. ±3 Hz.

   a. Maximum power consumption of 20 watts.

   b. If the device requires operating voltages of less than 120 VAC, the appropriate voltage converter shall be supplied. All voltage conversion devices shall also be temperature hardened as specified herein for location (field or central).

   c. The equipment or it’s voltage converter shall operate within a voltage range of 90 VAC to 135 VAC.

   d. Encoders shall provide for automatic recovery from an over or under voltage condition when prime power has returned to the tolerance values specified herein. All configuration parameters shall be stored in non-volatile memory and no reprogramming or manual adjustments shall be required upon power recovery.

3. Video Data Requirements
   a. The Encoder shall be capable of streaming a minimum of the following Video Compression Technology types:
      -
      - Stream 1: H.264 (Video Coding Experts Group (VCEG)/Moving Picture Experts Group)
      - Stream 2: H.264 (Video Coding Experts Group (VCEG)/Moving Picture Experts Group)
      - Snapshot: JPG full-frame capture
   b. The Encoder shall be capable of streaming multiple bandwidth and compression types simultaneously per video input channel.
   c. The Encoder shall support streaming multicast and unicast streams simultaneously.
   d. The Encoder shall have the ability to automatically initiate and stream a multicast stream upon starting without any remote request to join the multicast group.
   e. The Encoder shall support multiple simultaneous Real Time Streaming Protocol (RTSP) requests.
   f. The Encoder shall be able to supply multiple unique and independent video streams with frame rate, bit rate, and image size settings adjustable through an RTSP request.
   g. The encoder shall support a minimum of 2 simultaneous unique and independent H.264 video streams with frame rate, bit rate, and image size settings adjustable per video input channel.
   h. Encoders shall be a hardware-based network device able to accept a minimum of one analog National Television System Committee (NTSC) video input and encode for transport across IP networks.
   i. Encoders shall be specifically designed for network operation, and adhere to ISO standards.
   j. Support the following minimum encoded resolutions:
      -
      - Stream 1: NTSC – Full D1
      - Stream 2: CIF/SIF
      - Snapshot: NTSC – Full D1
   k. Dynamic bandwidth control: Provide up to the following or greater rates (The data rate shall be defined as the maximum committed bandwidth to be utilized, which includes data bursting.).
      - Stream 1: 3 Mbps at D1
      - Stream 2: 1 Mbps at CIF/SIF
   l. Bandwidth increments shall be user configurable via the network, independently per stream and snapshot. The minimum bandwidth setting shall be 56Kbs or less.
   m. Encoder streams shall be capable of being set to variable or constant bit rates.
   n. The default bandwidth for the Encoders as furnished shall be set to 2Mbps when communicating over fiber and 56kbs when communicating otherwise.
   o. Provide on-board buffered video memory for protection against potential network disruptions.
   p. Encoders shall be capable of providing JPG snapshots and transfer image via FTP either by push or pull at a user-defined interval minimally between 60 and 300 seconds.
   q. Encoded streams shall be fully compatible with the NaviGAtor software decoding system and with VLC (Video LAN Client.)

r. The encoder system, including processor, internal memory access and all data paths, shall operate with the following stream settings running simultaneously with no performance degradation of any stream, serial data interface, or device management interface:

- Stream 1: 2Mbps/NTSC – Full D1/30 frames per second/RTP
- Stream 2: 192Kbps/SIF/15 frames per second/RTP
- Snapshot: NTSC – Full D1/120 second capture interval

4. Network Requirements
   a. Encoders shall meet the following minimum network requirements:
   b. Network connection shall be Ethernet Compliant IEEE 802.3, 802.3u, and 802.3x; 10/100 Mbps or higher, auto sensing full/half-duplex operations.
   c. Encoders shall provide encapsulation of each of the video streams in UDP packet and TCP packets, depending on stream configuration, for network transmission.
   d. Encoders shall connect to a network device (i.e., Ethernet switch/router, IP wireless device, etc.) via a RJ-45 connector through Category 5eor higher quality stranded patch cords.
   e. All network RJ-45 ports shall be standard EIA/TIA-568-A pin-outs and shall be rated at 10/100Mbps or greater.
   f. All Encoders provided by the Contractor shall be fully interoperable without customization or the addition of appliances within either the remote or primary communications network. All devices shall be fully interoperable with the backbone communications network.
   g. Static management interface IP Addressing (class A, B, and C).
   h. Static IP Addressing of the multicast group individually and independently for each stream.
   i. RTP, UDP, Unicast and IP Multicast (Internet Group Multicast Protocol / IGMP V2) features for digital video transmission, individually and independently for each stream.
   j. Encoders shall support Real Time Streaming Protocol (RTSP) over RTP, individually and independently for each stream.
   k. Encoders shall support multiple stream requests, individually and independently for each stream.
5. Serial Data Interface Requirements
   The Encoder shall meet the following minimum serial data interface requirements:
   a. The Encoder shall provide bi-directional serial communications over Ethernet 10/100 Base-TX via the following methods:
      - Encoder serial port to Decoder serial port data stream.
      - IP socket to Encoder serial port by TCP protocol.
   b. Each serial port shall provide full-duplex serial interface and data rates up to 115.2 Kbps (minimum).
   c. Serial port shall be software configurable, locally or over the network, to EIA-232/422/485 mode of operation as defined by the EIA for data format, data rate, and data structure (e.g., baud rate, the number of bits, parity, stop bits, flow control, etc.) via the management software provided.
   d. No serial adaptors or interface converters shall be permitted.
   e. Encoders shall be capable to use the serial interface port to support PTZ camera control functions.
   f. Encoder serial port shall provide IP addressing and socket number selection and provide the capability to establish an IP connection directly from an operator workstation or server to any Encoder IP address and socket

number to transport serial data, independent of whether or not any video stream for that encoder is being viewed.

6. On Screen Display Requirements

   The Encoder shall provide the following On-Screen Display (OSD):

   a. Encoders shall support a static text insertion capability on all streams and shall be capable of inserting a minimum of two (2) user configurable text messages of at least 20 characters in length on separate lines, in user-configurable positions anywhere on the image.

   b. Encoders shall support JPG image insertion on all streams in either the upper left or upper right positions in the image, using a JPG file(s) stored in the Encoder's configuration.

   c. JPG image insertion shall be scalable per stream according to the stream resolution, or there shall be the capability to insert a different JPG image file for each stream.

   d. Encoders shall have the option to display or not display the OSD.

7. Management Requirements

   a. Encoders shall be manageable through SNMP (v2), HTTP, FTP/TFTP, and/or Telnet/CLI.

   b. Encoders shall have a NTP or SNTP client.

   c. The management system shall be provided to remotely configure and diagnose the Encoder.

   d. Have capability to reset/reboot and firmware upload via the methods listed above.

   e. Have the capability to remotely change any of the device configuration settings including bit rates, image resolution and compression settings and serial interface type.

   f. Provide pre-defined optimized video compression and streaming settings for various bit rates.

   g. Provide update capability for the firmware in the Encoder from the central site. Ability to access the serial number, firmware number, IP address and equipment configuration.

   h. Have the capability to upload firmware to multiple units automatically.

   i. Provide ability for remote firmware upgrades.

   j. Provide a command-line interface on the console port for local management.

   k. Provide administrative access control via a configurable password.

   l. Provide support for managing the administrative security parameters via both the Local Management and Remote Management interfaces required herein.

   m. Provide support for managing the following video streaming parameters via the Remote Management functionality required herein.

      - Target address and port (per stream)
      - TTL parameter
      - Resolution (per stream)
      - Frame rate (per stream)
      - I/P ratio (per stream)
      - Encoding bit rate (per stream)
      - On-screen display

C. Video Encoder, Type C – Card

Video Encoder, Type C- Card is a high density encoder unit (card) for multiple video signals, with one encoder per video signal, suitable for control center use in a slot based chassis.

1. General

a. Each encoder of a Video Encoder Type C- Card shall meet all the Video Encoder, Type B requirements except the physical requirements as noted in section 936.2.06.B.

b. All Contractor provided Video Encoder Type C- Cards shall be compatible with, and of the same make as Video Encoder, Type C – Chassis provided by the Contractor.

c. All Contractor provided Video Encoder Type C- Cards shall be compatible with, and of the same make as standalone Video Encoder, Type B provided by the Contractor.

2. Physical

a. Each Video Encoder Type C- Card shall include a minimum of 4 encoders per card with a corresponding number of BNC ports per encoder.

b. Each Video Encoder Type C- Card shall include one RJ-45 Network port: 10/100 Mbps.

c. Video Encoder Type C- Card shall be fully contained and obtain power from the Video Encoder, Type C Chassis.

D. Video Encoder, Type C – Chassis

Video Encoder, Type C - Chassis is a high density rack mount unit that supports multiple Video Encoder Type C or Video Decoder Type C cards suitable for control center use.

1. General

All Contractor provided Video Encoder Type C- Chassis shall be compatible with, and of the same make as Video Encoder, Type C – Cards provided by the Contractor

2. Physical

Chassis shall support a minimum of 12 Video Encoder, Type C cards, or 12 Video Decoder, Type C cards, or a combination thereof up to the minimum total cards.

a. Chassis shall be 7U or less and be 19” rack mountable.

b. Each Chassis shall be capable of operating on 1 internal power supply.

c. Each Chassis shall be capable of supporting a minimum of 2 internal power supply.

E. Video Encoder, Type D

Video Encoder, Type D is a standalone, environmentally hardened encoder for a single video signal, suitable for field cabinet use that is compatible with the existing legacy encoder and decoder video systems and otherwise would not meet Type B requirements.

1. General

Encoders of this Type shall be of the same make and model of encoder(s) that it shall replace, share communication in a drop and add link with, or with the decoder that shall decode it’s video, unless otherwise approved by the Engineer.

F. Video Encoder, Type E – Cards

Video Encoder, Type E-Cards is a high density encoder unit for multiple video signals, with one encoder per video signal, suitable for control center use with the existing legacy encoder and decoder video systems and otherwise would not meet Type B requirements.

1. General

Encoder Cards of this Type shall be of the same make and model of the Encoder Card(s) that it shall replace, or with the Encoder Card(s) that resides in the same chassis that it shall be added to unless otherwise approved by the Engineer.

G. Video Encoder, Type E – Chassis

Video Encoder, Type E - Chassis is a high density rack mount unit that supports multiple Video Encoder Type C or Video Decoder Type C cards suitable for control center use with the existing legacy encoder and decoder video systems and otherwise would not meet Type B requirements.

936.2.07 Video Decoder (All Types)

A. Video Decoder, Type A

Not Used

B. Video Decoder, Type B

Video Decoder, Type B is a standalone decoder for the decoding of IP streams of the formats compatible of the Video Encoder Type B streams into a standard NTSC analog video stream output.

1. General
   a. All Video Decoder Type B shall meet all the requirements of a Video Encoder Type B unless otherwise stated.

   b. Be new and shall be from the same manufacturer and be fully compatible and interoperable with each type provided.

2. Physical and Environmental
   Video Output Connector : BNC

   a. The video output performance measures shall comply with NTSC and EIA requirements, including the EIA-170 standard, with a nominal composite video of 1 volt peak-to-peak (Vp-p). The equipment shall have an electrical impedance of 75 ohms.

3. Video Data Requirements
   a. The Decoder shall be capable of decoding a minimum of the following Video Compression Technology types:

      - H.264 (Video Coding Experts Group (VCEG)/Moving Picture Experts Group)
      - MPEG -4 (Moving Picture Experts Group)
      - MJPEG Motion JPEG (Moving Picture Experts Group)

   b. The Decoder shall support joining multicast groups and decode the streams of the Type and video Compression technology listed above.

   c. The Decoder shall support decoding unicast streams from a of the Type and video Compression technology listed above.

   d. The Decoder shall support decoding of streams from RTSP requests of the Type and video Compression technology listed above

   e. The Decoder shall be able to decode unique and independent video streams with frame rate, bit rate, and image size settings adjustable through an RTSP request.

   f. Decoders shall be a hardware-based network device able to provide a minimum of one analog National Television System Committee (NTSC) video output and decode IP video transported across IP networks.

   g. Decoders shall be specifically designed for network operation, and adhere to ISO standards.

   h. Support the following minimum encoded resolutions:

      - NTSC - Full D1
      - CIF/SIF
      - QCIF/QSIF
      - Decoder streams shall be capable of decoding streams set to variable or constant bit rates

4. Network Requirements. Decoders shall meet the following minimum network requirements:

   Network connection shall be Ethernet Compliant IEEE 802.3, 802.3u, and 802.3x; 10/100 Mbps or higher, auto sensing full/half-duplex operations.

5. Serial Data Interface Requirements
6. On Screen Display Requirements
    a. Decoders shall support a static text insertion capability and shall be capable of inserting a minimum of one (1) user configurable text messages of up to 20 characters in length.
    b. Decoders shall be able to generate a date and time stamp in the video stream and shall be synchronized to a time-server on the network.
    c. Decoders shall be able to display camera title in the video stream.
    d. Decoders shall have the option to display or not display the on-screen text.
7. Management Requirements
    a. Decoders shall be manageable through SNMP (v2), HTTP, FTP/TFTP, and/or Telnet/CLI.
    b. The management system shall be provided to remotely configure and diagnose the Decoder.

C. Video Decoder, Type C – Card

Video Decoder, Type C- Card is a high density Decoder unit (card) for multiple video signals, with one Decoder per video signal, suitable for control center use in a slot based chassis.

1. General
    a. Each Decoder of a Video Decoder Type C- Card shall meet all the Video Decoder, Type B requirements except the physical requirements as noted in section 936.2.06.B.
    b. All Contractor provided Video Decoder Type C- Cards shall be compatible with, and of the same make as Video Decoder, Type C – Chassis provided by the Contractor
    c. All Contractor provided Video Decoder Type C- Cards shall be compatible with, and of the same make as standalone Video Decoder, Type B provided by the Contractor
2. Physical
    a. Each Video Decoder Type C- Card shall include a minimum of 4 Decoders per card with a corresponding number of BNC ports per Decoder.
    b. Each Video Decoder Type C- Card shall include one RJ-45 Network port: 10/100 Mbps.
    c. Video Decoder Type C- Card shall be fully contained and obtain power from the Video Decoder, Type C Chassis.

D. Video Decoder, Type C – Chassis

Video Decoder, Type C - Chassis is a high density rack mount unit that supports multiple Video Decoder Type C or Video Decoder Type C cards suitable for control center use.

1. General
    a. All Contractor provided Video Decoder Type C- Chassis shall be compatible with, and of the same make as Video Decoder, Type C – Cards provided by the Contractor
2. Physical
    a. Chassis shall support a minimum of 12 Video Decoder, Type C cards, or 12 Video Decoder, Type C cards, or a combination thereof up to 12 total cards.
    b. Chassis shall be 7U or less and be 19” rack mountable.
    c. Each Chassis shall be capable of operating on 1 internal power supply.
    d. Each Chassis shall be capable of supporting a minimum of 2 internal power supply.

E. Video Decoder, Type D

Video Decoder, Type D is a standalone, environmentally hardened Decoder for a single video signal, suitable for field cabinet use that is compatible with the existing legacy Decoder and decoder video systems and otherwise would not meet Type B requirements.

1. General

   Decoders of this Type shall be of the same make and model of Decoder(s) that it shall replace, share communication in a drop and add link with, or with the decoder that shall decode it's video, unless otherwise approved by the Engineer.

F. Video Decoder, Type E – Cards

Video Decoder, Type E-Cards is a high density Decoder unit for multiple video signals, with one Decoder per video signal, suitable for control center use with the existing legacy Decoder and decoder video systems and otherwise would not meet Type B requirements.

1. General

   Decoder Cards of this Type shall be of the same make and model of the Decoder Card(s) that it shall replace, or with the Decoder Card(s) that resides in the same chassis that it shall be added to unless otherwise approved by the Engineer.

G. Video Decoder, Type E – Chassis

Video Decoder, Type E - Chassis is a high density rack mount unit that supports multiple Video Decoder Type C or Video Decoder Type C cards suitable for control center use with the existing legacy encoder and decoder video systems and otherwise would not meet Type B requirements.

1. General

   Encoder Chassis of this Type shall be of the same make and model of the Encoder Chassis that it shall replace unless otherwise approved by the Engineer.

936.2.08 Delivery, Storage, and Handling

For Furnish Only items, provide all materials in protective packaging suitable for shipping and storage. Label all boxes with contents, including manufacturer name, model, serial numbers, and project number. Package each product/system in individual boxes as units of one complete unit. Multiple boxes for one assembly is acceptable, but multiple assemblies in the same box is not. Deliver assemblies to the Department at the location specified by the Engineer. Deliver at one time the full quantity of complete assemblies as shown in the Plans; multiple deliveries are not acceptable.

936.3 Construction Requirements

Ensure that all construction for the equipment, materials, components and assemblies of the CCTV System specified conform to the CCTV manufacturer's requirements and recommendations.

936.3.01 Personnel

Not applicable

936.3.02 Equipment

Not applicable

936.3.03 Preparation

Not applicable

936.3.04 Fabrication

Not applicable

936.3.05 Construction

A. General Requirements

Request that the Department establish the utility service(s) required for a CCTV installation as described in Section 682.

B. CCTV System, All Types

1. Installation Requirements

   Mount the camera system assembly and the mounting bracket arm at the cardinal direction and height as shown in the Plans.

   Install cables between the camera system assembly and the equipment cabinet inside new hollow metal or concrete support poles unless otherwise specified. Where devices are installed on existing wood poles, install cabling on the wood poles in rigid metal conduit risers of minimum 2 in (50.8 mm) diameter. Use weather heads on all nipple and conduit openings. Neatly install and route cabling to minimize movement in the wind and chafing against the pole, device or bracket. Form a drip loop at the weather head and route cabling to prevent water entry into the weatherhead or mounting bracket arm. Install the mounting bracket arm no more than 8 in (204 mm) above the weatherhead, and install a drip loop that is no more than 6 in (152 mm) below the weatherhead at the loop's lowest point.

   Install the cabinet interface assembly components in the equipment cabinet as shown in the CCTV system detail drawings. Neatly arrange and dress all wiring, firmly lace or bundle it, and mechanically secure the wiring without the use of adhesive fasteners. Route and secure all wiring and cabling to avoid sharp edges and to avoid conflicts with other equipment or cabling. Route all CCTV cables separate from any 120VAC power wiring or surge suppressor ground wiring. Neatly coil and dress between 3 ft (1 m) and 5 ft (1.5 m) of cables in the bottom of the cabinet. Dress and route grounding wires separately from all other cabinet wiring and with the minimum length possible between the suppressor and the ground bussbar. Do not splice any cable, shield or conductor used for video, control, communications signaling, power supply, or grounding.

   Fasten all components of the cabinet interface assembly to be mounted on the equipment cabinet side panel or on the CCTV Interface Enclosure with stainless steel hex-head or Phillips-head machine screws. Install the screws into tapped and threaded holes in the panels. Fasten stud-mounted components to a mounting bracket providing complete access to the studs and mounting nuts. All fastener heads and nuts (when used) shall be fully accessible within the equipment cabinet, and any component shall be removable without requiring removal of other components, panels, or mounting rails. Do not use self-tapping or self-threading fasteners.

2. CCTV System Configuration

   Program and configure the CCTV system in accordance with the procedure below. Provide all required documentation in writing with all data recorded in the format of the NaviGAtor Standard CCTV Control Protocol. Perform the CCTV system configuration in accordance with the acceptance procedures in subsection 936.3.06. Configure each CCTV system with the communications address specified by the Department, prior to any acceptance testing at a given CCTV system site. Configure the communications address as "001" unless otherwise shown in the Plans or directed by the Engineer.

   GDOT's "ATMS Surveillance Camera Control Integration and Calibration Procedure" is as follows:

   a. Record the position status setting for the full pan left and pan right stops. The pan left and pan right stops are defined as the camera positions when the pole initially comes into view from either direction at maximum zoom.

   b. Record the position status setting and angle (degrees from horizon) for maximum tilt up and maximum tilt straight down (90 degrees down from horizontal).

   c. Record the position status settings for each end of maximum focus range.

   d. Record the position status settings for maximum zoom out and zoom in.

   e. Provide to the Department the following information from each field installation site:

      - Location (as shown in Plans)
      - Height of camera (ft) above travel lanes
      - Azimuth (compass heading in degrees at camera's right stop as defined above)
      - Azimuth (compass heading in degrees at camera's left stop as defined above)
      - Device ID as shown on the Plans (example: CAM001)
      - CCTV system communications address (example: 001)
      - IP address, Subnet mask, Gateway port/socket of serial port on Encoder

- Multicast address
- Video switch input port (when connected)
- Comments

3. As-Built Drawings

Furnish as-built CCTV system wiring diagrams, identified by location. Include all wiring, cabling, conductor function, connector type and connector pinouts.

936.3.06 Quality Acceptance

A. General

Acceptance testing of CCTV System, all Types consists of three phases: 1) field installation testing; 2) CCTV system site testing; and 3) burn-in period. After the Engineer's granting of burn-in period completion, obtain CCTV system acceptance. Perform acceptance testing for all equipment, hardware and work provided under this Contract, including each CCTV video surveillance field installation assembly and all associated communications hardware at a control center or communications hub. Perform all testing in the presence of the Engineer. Notify the Engineer of a desired acceptance test schedule no less than fourteen calendar days prior to beginning the testing except for testing using the NaviGAtor software and existing NaviGAtor control center and communications equipment. For acceptance testing using the NaviGAtor software and existing NaviGAtor control center and communications equipment, coordinate this testing with the Engineer no less than 30 days prior to the start of this testing.

Except as provided herein regarding the Department's NaviGAtor software, develop, provide all equipment for, and perform all acceptance testing for all CCTV system equipment, hardware and work. Develop detailed and thorough test procedures with full test plan descriptions, test and measurement equipment listings, and test results data sheets. Submit these test plans to the Engineer for approval. The Engineer will notify the Contractor of the approval or disapproval of the test procedures; only test procedures approved by the Engineer can be used. Provide all necessary testing and measurement equipment.

Make the acceptance testing plan a detailed and thorough procedure for both the field installation test and the CCTV system site test. Demonstrate that the CCTV system equipment, hardware and work meet all requirements of the Contract. These requirements include but are not limited to all design, construction, materials, equipment, assembly, documentation of manufacturer's certification of assembly and configuration, environmental, performance, communications, video and data communications signal strength and clarity, compatibility with the NaviGAtor software, and documentary requirements of the Contract.

Prior to the beginning of any acceptance testing at a given CCTV system site, complete all configuration and documentation associated with GDOT's "ATMS Surveillance Camera Control Integration and Calibration Procedure," described in Subsection 936.3.05.B. Be prepared to demonstrate such work.

B. Field Installation Test

Perform the Field Installation Test as an onsite test of the complete field installation assembly less the communications components; no acceptance testing at a given site can begin until all work associated with that site is complete, not including the communications components. For the field equipment installation test, use a PC system, CCTV Embedded Protocol control software, and a color video monitor to demonstrate full operation of the CCTV site. Demonstrate operation to include pan, tilt, focus, zoom, iris, position feedback, and communications address configuration. Measure the video signal strength at the video connector of the communications equipment.

C. CCTV System Site Test

For the CCTV System Site Test, demonstrate proper CCTV system performance at the TMC or other control center determined by the Department. Perform the CCTV System Site Test only after successful completion of the field installation acceptance test. Demonstrate the complete video image, camera/lens control, and communications operation from each CCTV site to the TMC. Use the NaviGAtor software and existing NaviGAtor control center and communications system to demonstrate the compatibility of the CCTV equipment and installation in its permanent NaviGAtor configuration. Verify data communications (pan, tilt, focus, zoom, iris, position feedback) from the TMC as defined in the Department-approved test procedures.

D. Burn-in Period

1. General Requirements

Provide a 30-day burn-in period for all work and equipment included in the Contract. The burn-in period shall consist of the field operation of the CCTV system in a manner that is in full accordance with the CCTV system requirements of the Plans and Specifications. An acceptance test procedure is not required for the system burn-in.

Conduct only one (1) burn-in period on the entire Contract. Commence with the burn-in period only after meeting all of the following requirements:

a. All work required in all Contract documents for CCTV (may be combined with construction contract) (except this burn-in period) has been completed and inspected by the Engineer.

b. Successfully complete all Acceptance Testing.

Commence with the burn-in period upon written authorization by the Department to commence. Terminate the burn-in period 30 consecutive days thereafter unless an equipment malfunction occurs. Stop the burn-in period for the length of time any equipment is defective. After repairing the equipment so that it functions properly, resume the burn-in period at the point it was stopped.

Successful completion and acceptance of the burn-in period will be granted on the 30th day unless any equipment has malfunctioned during the 15th through 30th day of the burn-in period. If any equipment has failed during the 15th through 30th day, final acceptance will be withheld until all the equipment is functioning properly for 15 days after repair.

When a specific piece of equipment has malfunctioned more than three times during the 30 day burn-in period, replace that equipment with a new unit and repeat the 30 day burn-in period.

2. Contractor Responsibilities

   During the burn-in period, maintain all work under this Contract in accordance with the Specifications. Restore any work or equipment to proper operating condition within 12 hours after notification.

3. Department Responsibilities

   Department responsibilities during the burn-in period will be as follows:

   a. Expeditious notification of Contractor upon failure or malfunction of equipment

   b. In the event that the Contractor does not provide the services enumerated above under his Contract responsibilities, the Department or its authorized agents may in the interest of public safety take emergency action to provide for adequate traffic control. Pay any costs incurred as a result of these emergency actions. Such action by the Department will not void any guaranties or warranties or other obligations set forth in the Contract.

4. Burn-In Period Acceptance

   The Department will make burn-in period acceptance after satisfactory completion of the required burn-in period and on the basis of a comprehensive field inspection of the complete CCTV system in accordance with the specifications. Upon burn-in period acceptance but prior to Final Acceptance of the entire Contract, maintain the complete CCTV system in accordance with the requirements of Subsection 936.3.07.

E. Bench Acceptance Test

For retrofit assemblies, perform the bench acceptance test as an onsite test for all assemblies furnished as shown in the Plans. Furnish a benchtop stand and associated hardware for the camera system assembly mount that securely holds the camera system assembly while the camera is being operated. For the bench acceptance test, use a PC system, CCTV Embedded Protocol control software, and a color video monitor to demonstrate full operation of the CCTV site. Demonstrate operation to include picture quality, pan, tilt, focus, zoom, iris, position feedback, and communications address configuration.

936.3.07 Contractor Warranty and Maintenance

Provide a manufacturer's support (usual and customary warranties) period of three years for all equipment and materials furnished and installed as part of the pay item for CCTV system equipment and materials. Include warranties or guarantees for system camera assembly and mount, cabinet interface assembly, and cabling/connector. Begin warranty upon successful completion of the CCTV System burn in period and acceptance for maintenance.

Transfer Manufacturer's and Contractor's warranties or guarantees to the agency or user responsible for the CCTV system maintenance, The warranties and guarantees shall be continuous throughout their duration, and state that they are subject to such transfer.

936.3.08 Training

Provide installation, operations, and maintenance training on the CCTV equipment at a site in the project area. Personnel trained by the various equipment manufacturers and authorized by said manufacturers shall perform the training. Include in the cost of training all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training. Furnish a training notebook in a labeled 3-ring binder to each trainee.

Provide installation, operations and maintenance training for up to twelve (12) people. Include in this training both classroom training and hands-on training. Limit in-shop and in-field training to group sizes of four (4) people at a time. Conduct all training in half-day sessions. Two half-day sessions may be held on the same day. The total of the training shall consist of at least six (6) clock hours of training for each participant. Provide a course content of, at a minimum, the following:

- Installation of all CCTV equipment
- Operations of all CCTV equipment
- Explanation of video quality
- Maintenance of all CCTV components
- Use of the CCTV embedded protocol control software
- Measurement of video signals
- Discussion of all warrantee clauses
- Hands-on use of CCTV equipment in signal shop environment for each trainee
- In-field maintenance training
- Video Encoders and Decoders
- Installation of all digital video compression system equipment
- Explanation of MPEG-4 digitized video
- Maintenance of all digital video encoder and decoder system components including software
- Measurement of digital video signals
- Hands-on use of digital video transport system equipment for each trainee

CCTV and Encoders/Decoders training shall be provided in conjunction with the digital video transport system training specified in Section 939. The total of the CCTV and video transport system training shall consist of at least eight (8) clock hours of training for each participant. Meet all video transport system training requirements of Section 939.

936.4 Measurement

936.4.01 CCTV System

CCTV systems, Type B, are measured for payment by the number actually installed, complete, functional, and accepted. Unless otherwise specified in the Plans, furnish and install the following minimum items for a CCTV system:

- camera system assembly including the camera, lens, pan/tilt drive (except for Type D), control electronics and environmental enclosure.
- pole-mounting hardware.
- cabinet equipment, including but not limited to the cabinet interface assembly and all associated wiring, conductors, terminal blocks, and surge suppression.

- all weather heads, vertical conduit risers and conduit hardware on the CCTV support pole for power service, grounding, communications and control.
- all cables, connectors, hardware, interfaces, supplies, and any other items necessary for the proper operation and function of any CCTV system component with any other CCTV system component.

936.4.02 Encoders/Decoders

A. Video Encoders, Type B

Video Encoders, Type B, with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

B. Video Encoders, Type C

Video Encoders, Type C, with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

C. Video Decoders, Type B:

Video Decoders, Type B, with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

D. Video Decoders, Type C:

Video Decoders, Type C, with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

E. Video Decoders, Type D

Video Decoders, Type D, with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

F. Video Decoders, Type E:

Video Decoders, Type E, with rack mounting hardware are measured for payment by the number actually installed, complete, functional and accepted.

936.4.03 Testing

Testing as described in section 936.3.06 is considered incidental to the cost of the camera systems and installation and shall not be paid for separately.

936.4.04 Training

Training is measured as a lump sum for all supplies, equipment, materials, handouts, travel, and subsistence necessary to conduct the training.

936.4.05 Limits

Not applicable

936.5 Payment

936.5.01 CCTV System

CCTV systems of the Type specified in the Plans are paid for at the Contract Unit Price. Payment is full compensation for furnishing and installing or delivering the CCTV system.

Payment for CCTV systems is made under:

Item No. 936	CCTV System, Type ___	Per each
Item No. 936	CCTV System, Type B, Retrofit Assembly	Per each
Item No. 936	CCTV System, Type ___, Retrofit Assembly (Furnish Only)	Per each
Item No. 936	CCTV Camera lowering system	Per each
Item No. 936	Video Encoder, Type ___	Per each
Item No. 936	Video Decoder, Type ___	Per each

936.5.02 Training

The Department will pay twenty-five (25%) of the total contract bid amount for training upon approval of the Training Plan. The Department will pay the remaining seventy-five (75%) after completion of all training as described in Subsection 936.3.08. The total sum of all payments cannot exceed the original contract amount for this item.

Payment for training is made under:

Item No. 936	Training	Lump Sum

936.5.03 Adjustments

Not applicable

February 2, 2015

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

PROJECT #:
P.I. #:

Section 999—Miscellaneous (Dry Swale Edge Drains)

Add the following:

999.1 General Description

This work consists of constructing dry swale edge drains by installing drainage aggregate, sand, plant topsoil, filter fabric, pipe, and other incidentals and grading as necessary according to the Specifications and the details shown in the plans or as directed by the Engineer.

999.1.01 Related References

A. Standard Specifications

Section 301—Soil Cement

Section 574—Edge Drains

Section 700—Grassing

Section 711—Turf Reinforcement Matting

Section 800—Coarse Aggregate

Section 801—Fine Aggregate

Section 814—Soil Base Materials

Section 830—Portland Cement

Section 839—Corrugated Polyethylene Underdrain Pipe

Section 881—Fabrics

Section 890—Seed and Sod

Section 893—Plant Topsoil

B. Referenced Documents

(ASTM D-4491)
(ASTM D-4751)
(ASTM D-3786)
(ASTM D-4632)
(ASTM D-4632)
(ASTM D-4833)
(ASTM D-4533)
(ASTM D-5890)

Section 999-Miscellaneous (Dry Swale Edge Drain)

999.1.02 Submittals

General Provisions 101 through 150.

999.2 Materials

Provide the materials shown in the plans, such as sand, filter fabric, drainage aggregate, pipe, plant topsoil, and other accessories as necessary. Materials shall meet the requirements of the following Specifications:

Material	Requirement
10 NS Natural Concrete Sand	Subsection 801.2.02
6" Corrugated Polyethylene Underdrain Pipe	Sections 574, 839
Nonwoven Plastic Filter Fabric	ASTM D-4491: permittivity = 1.30 sec^{-1} ASTM D-4751: AOS = 70 US standard sieve ASTM D-3786: Mullen burst strength = 280 psi ASTM D-4632: Grab tensile strength = 160 lb ASTM D-4632: Grab tensile elongation = 50% ASTM D-4833: Puncture Resistance = 85 lb ASTM D-4533: Trapezoidal tear strength = 60 lb
Drainage Aggregate, Size No. 78	Subsection 800.2.01
Plant Topsoil	Subsections 893.2.01, 814.2.01.A.8
Soil-Cement Material	Subsection 814.2.02
Portland Cement	Subsection 830.2.01
Pulverized Bentonite	ASTM D-5890 Swell Index
Bunch Grass and Sod	Sections 700, 890
Turf Reinforcement Matting Type 2*	Section 711
*Use for soil cement ditch dam protection.	

999.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

999.3 Construction Requirements

999.3.01 Personnel

General Provisions 101 through 150.

999.3.02 Equipment

General Provisions 101 through 150.

999.3.03 Preparation

General Provisions 101 through 150.

999.3.04 Fabrication

General Provisions 101 through 150.

999.3.05 Construction

Side slopes and top of swales are to be roughed in during normal stage construction. Complete dry swale edge drains as shown in the construction plans after final grade and stabilization is reached. Enclose the 10 NS natural concrete sand filter with nonwoven geotextile on all four (4) sides: top, both sides, and bottom. Construct mat-protected,

permanently grassed road foreslopes above and adjacent to dry swale edge drains immediately after each dry swale edge drain is installed.

Construct ditch dams with soil cement compacted to 95% proctor. The composition of the soil cement by dry weight shall be 5% pulverized bentonite, 10% Portland cement, and 85% soil. Prepare the soil cement using the central plant mixing method.

Key ditch dams into the swale bottom a minimum of 2.0 feet deep. Protect ditch dams with TRM 2 or higher as directed by the Engineer. Anchor the TRM with staples from 5 feet upstream of the dam toe to 5 feet downstream of the dam leeward toe.

Plant topsoil thickness shall be 6 inches. Natural concrete sand thickness shall be 24 inches. Drainage aggregate thickness shall be 9 inches.

999.3.06 Quality Acceptance

General Provisions 101 through 150.

The Contractor shall perform comprehensive inspections of the enhanced dry swales after every major storm event of 0.5 inches of rainfall or greater in a 24-hour period until the project has final acceptance by the Department. These inspections shall be performed in accordance with the criteria established in the Georgia Department of Transportation Stormwater System Inspection and Maintenance Manual (GDOT I&M Manual). Inspections shall be documented using the GDOT Enhanced Swale Inspection Checklist Form B-3 in Appendix B of the GDOT I&M Manual. Maintenance shall be performed as directed by the Engineer and the GDOT I&M Manual.

999.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

999.4 Measurement

Dry swale edge drains are measured for payment by linear feet (meters) installed and accepted. The outlet control structure and any outlet pipe are paid for separately.

999.4.01 Limits

General Provisions 101 through 150.

999.5 Payment

Specified dry swale edge drains are paid for at the contract price per linear foot (meter). The outlet control structure and any outlet pipe are paid for separately.

Payment is full compensation for:

- Furnishing the material and labor
- Preparation and grading required to install dry swale edge drains
- Installation of the drainage aggregate, pipe, 10 NS sand, filter fabric, and plant topsoil as shown in the details for construction of dry swale edge drains
- Any other incidentals, such as pipe fittings, required to install dry swale edge drains
- Comprehensive inspections and maintenance

Payment is made under:

Item No. 999	Dry swale edge drain	Per linear foot (meter)

999.5.01 Adjustments

General Provisions 101 through 150.

Date: December 12, 2002
First Use Date: December 12, 2002
Date Submitted: December 12, 2002

DEPARTMENT OF TRANSPORTATION
STATE OF GEORGIA

SPECIAL PROVISION

Project No._____

County_____

P.I. No._____

Section 453 – Portland Cement Concrete Whitetopping

Add the following:

453.1 General Description

This Work consists of constructing a Portland cement concrete Whitetopping over an existing asphalt pavement according to the Specifications and Plan Details.

453.1.01 Definitions

Average Temperature—Average of predicted high and the predicted low in degrees Fahrenheit (Celsius)

453.1.02 Related References

A. Related Specifications

Section 500

Section 800

Section 801

Section 830

Section 831

Section 832

Section 880

B. Related Documents

ASTM C 1116

GDT 26

GDT 27

453.1.03 Submittals

General Provisions 101 through 150.

453.2 Materials

A. Physical Properties

Ensure the materials meet these requirements:

Material	Requirement
Coarse Aggregate (Size No. 7)*	Subsection 800.2.01
Fine Aggregate (Size No. 10)**	Subsection 801.2.02
Portland cement***	Section 830
Admixtures	
Air Entraining Admixtures	Subsection 831.2.01
Retarding Admixtures	Subsection 831.2.02
Water Reducing Admixtures	Subsection 831.2.02
Curing Agents	Section 832
Water	Subsection 880.2.01
Polypropylene Fibers	ASTM C 1116—Type III fibers

*Coarse aggregate may be either Class A or B of the designated size except that when Limestone or Dolomite is used in whitetopping , Class A Coarse aggregate is required.

**Use natural sand for fine aggregate

***Use Type I or III Portland cement

B. Concrete Mix Designs

Coarse Aggregate Size No.	Minimum Cement Content, lb/yd^3 (kg/ m^3)	Polypropylene Fibers, lb/yd^3 (kg/m^3)	Maximum Water/Cement Ratio, lb/lb (kg/kg)	Entrained Air (%)	Minimum Compressive Strength @ 24 hours, PSI (MPa)
No. 7	800 (475 kg/m^3)	3.0 (1.8 kg/m^3)	0.43	5.0	3000 (20)

453.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

453.3 Construction Requirements

453.3.01 Personnel

General Provisions 101 through 150.

453.3.02 Equipment

General Provisions 101 through 150.

453.3.03 Preparation

General Provisions 101 through 150.

453.3.04 Fabrication

Manufacture the concrete for Portland cement concrete Whitetopping according to Section 500 of the Specifications and the requirements herein.

A. Batch Concrete

Batch concrete at the plant to produce concrete at the jobsite with a slump range from 2 in. (50 mm) to 3 in. (75 mm). Additional water may be added at the jobsite to attain the desired consistency [2 in. (50 mm) to 3 in. (75 mm) slump] provided that the maximum water-cement ratio is not exceeded.

B. Admixtures

Add an approved Type "F" high range water reducing admixture to promote workability. In addition to Type "F", add Type "A" or "D" admixtures according to these requirements:

Type "D" retarding admixture—Use when the average temperature is at or above 65°F (18 °C).

Type "A" or "D"—Use when temperature is below 65°F (18 °C).

Accurately measure and add admixtures to the concrete mixture. Ensure addition rates, dispensing and mixing of the admixture is according to the manufacturer's recommendations.

C. Polypropylene Fibers

Use an approved polypropylene fiber meeting the requirements of ASTM C 1116—Type III fibers. Add fibers at a rate of 3.0 lb/yd3 (1.8 kg/m3) at the plant site to insure uniformity of distribution throughout the mix, unless otherwise specified by the Engineer.

453.3.05 Construction

Use the following procedures to construct the Whitetopping:

A. Surface Milling

Mill pavement surfaces to provide a minimum Whitetopping depth of 4 in. (100 mm) in all areas. Multiple milling passes may be necessary. Ensure that adjacent passes of the milling operation do not leave depth variations greater than ½ in. (12 mm).

Make a transverse saw cut at each end of the asphalt section to provide a clean vertical face and ensure proper concrete thickness.

After milling, thoroughly clean the area with compressed air to remove all laitance, dust, grit and all foreign material. Protect the area, as necessary, to prevent contamination until placement. When areas are not adequately protected, additional cleaning will be required as directed by the Engineer.

B. Moisture Coat

After the surface has been milled, air blasted, cleaned and accepted, wet the surface immediately prior to concrete placement.

Accomplish this wetting of the surface just ahead of the placement by spraying with a fine mist without excess water puddling on the surface.

C. Placing and Consolidating

Use finishing machines or screeds that are mechanically operated supported outside the area of Whitetopping. Use transverse type screeds.

Ensure screeds are equipped with surface vibrators sufficient to thoroughly consolidate the concrete full depth, unless other methods are approved by the Engineer.

Screed vibrators may be supplemented with hand held vibrators to accomplish proper consolidation.

Promptly after the moisture coat has been applied, deposit the concrete on the milled surface, consolidate it and strike it off.

As placement proceeds, keep the concrete surface screeded to the required grade. Ensure that depressions are filled ahead of the screed, and that a small roll of mortar is kept on the leading edge of the screed.

Ensure that sound concrete is obtained at all joint edges during the concreting and screeding operation. Do not place excess grout or allow any excess grout to remain in these areas.

Apply a broom finish as soon as the surface permits.

D. Finishing

Ensure that the surface of the whitetopping does not deviate more than 1/8 inch (3 mm) when tested with a 10-foot (3.0 m) straightedge placed in both directions.

Provide a surface that meets the requirements of Section 439.3.06.H and Section 439.3.06.I for "Final Finish" and "Texture Depth" respectively.

E. Contraction Joints

Saw contraction joints at 4 ft. (1.2 m) maximum intervals throughout the entire placement in the transverse and longitudinal directions.

Do not saw parallel joints in either direction closer than 2 ft. (600 mm) to any edge of any construction joint in the Whitetopping. Do not place any joint within 1 foot of a wheel path.

Commence sawing as soon as the surface will permit without marring.

Special saws made to cut concrete at or near initial set may be allowed by the Engineer to expedite sawing and control stresses that may produce wild cracking.

Make all saw cuts to a depth of 0.75 in. ±0.125 in (19 mm ± 3 mm) and 0.125 in. (3 mm) wide.

F. Curing

Apply a curing compound immediately after the water sheen disappears and the surface finish is applied.

Uniformly spray the entire surface of the pavement with white pigmented curing compound immediately after finishing the surface and before the concrete has set.

453.3.06 Quality Acceptance

A. Concrete Acceptance Testing

1. Slump

   Determine the slump of concrete according to GDT 27 immediately prior to placement. Do not exceed a slump value greater than 7 ½ in (190 mm). Perform this acceptance after the addition of Type "F" water reducer.

2. Air Content

   Ensure the design air content is as shown above in the concrete design table. The concrete will be tested for air content according to GDT 26 at the jobsite, prior to placement. No concrete will be accepted which has an air content beyond the following limits:

Lower acceptance limit	3.0%
High acceptance limit	7.5%

   Perform the air content test for jobsite acceptance prior to the addition of Type "F" water reducing admixtures unless admixture is added at the plantsite.

453.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

453.4 Measurement

Whitetopping is measured by the cubic yard (meter).

453.4.01 Limits

General Provisions 101 through 150.

453.5 Payment

Whitetopping is paid for by the cubic yard (meter) inplace and accepted. Payment includes all materials and labor to mill and clean the existing pavement, place, finish, cure and saw joints in the Whitetopping.

Payment will be made under:

Item No. 453	Portland cement concrete whitetopping	Per cubic yard (meter)

453.5.01 Adjustments

General Provisions 101 through 150.

DEPARTMENT OF TRANSPORTATION

STATE OF GEORGIA

SPECIAL PROVISION

Project Number:

P.I. Number:

County

Add the following:

Section 927— Wireless Communications Installation

927.1 General Description

This work consists of furnishing materials and installing a wireless communications spread spectrum radio system with all necessary hardware in accordance with the plans and Special Provisions to provide a data link between field devices (i.e. Traffic Signal Controllers, Dynamic Message Signs, etc.). Provide radio system with bi-directional, full duplex communications between two "line-of sight" antennas using license free, spread spectrum technology operating in the 902-928 MHz frequency band.

It also includes all test periods, warranties and guarantees as designated in subsequent sections, and response to maintenance and operational issues as described in subsequent sections.

Apply for, obtain and pay for all utility services, communications services to, and pole attachment permits that are necessary for the wireless communications installation and operation required in the Plans. Maintain these utility services until final acceptance of the communications system.

Upon final acceptance, make an orderly and uninterrupted transfer of these services and permits to the local government or other jurisdiction that will be responsible for subsequent maintenance and operation.

927.1.01 Definitions

General Provisions 101 through 150.

927.1.02 Related References

A. Georgia Specifications

Section 106—Control of Materials
Section 631—Changeable Message Signs
Section 639—Strain Poles for Overhead Sign and Signal Assemblies
Section 647—Traffic Signal Installation
Section 682—Electrical Wire, Cable, and Conduit
Section 915—Mast Arm Assemblies
Section 923—Electrical Conduit
Section 925—Traffic Signal Equipment

Section 926—Wireless Communications Equipment

Section 935—Fiber Optic System

Section 938—Detection

Section 939—Communications & Electronic Equipment

B. Referenced Documents

National Electrical Manufacturers Association (NEMA) Traffic Control Systems Standards No. TS 1

NEMA Traffic Control Systems Standards No. TS 2

AASHTO Roadside Design Guide

The Manual on Uniform Traffic Control Devices (MUTCD), current edition

National Electrical Code (NEC)

National Electrical Safety Code (NESC)

GDT 7

GDT 24a

GDT 24b

GDT 67

927.1.03 Submittals

Submit to the Engineer material specifications information on all materials proposed for use on the project.

Written approval is required from the State Traffic Signal Engineer prior to beginning any work on the wireless communication installation.

A. Review

For all submittals, the State Traffic Safety and Design Engineer's review of the material should be completed within thirty (30) days from the date of receipt of the submission unless otherwise specified. The State Traffic Signal Engineer will advise in writing, as to the acceptability of the material submitted.

All material submittals for wireless communications equipment and materials used on the project will be reviewed by the Department's Traffic Signal Electrical Facility (TSEF). The material review should be completed within thirty (30) days from the date of receipt of the material submission unless otherwise specified. The State Traffic Signal Engineer will advise in writing as to acceptability of materials to be used on the project.

The State Traffic Signal Engineer may determine that the item is approved, in which case no further action is required; or the item may be partially or totally rejected in which case, modify the submittal as required and resubmit within fifteen (15) days. At this time, the review and approval cycle described above begins again.

The Department reserves the right to be reimbursed for reviewing any submittals after a second rejection.

B. Submittal Costs

No separate measurement or payment will be made for submittal costs.

C. Wireless Communications Item Certification

Submit six (6) copies of material catalog product numbers and descriptions to the Engineer. Reference the project number, P.I. number and include with submittal of all other traffic signal items.

- Spread Spectrum Wireless Communications Radio Unit
- Configuration and Diagnostic Software
- Antenna
- Site Survey Kit
- Configuration Cable
- Antenna Patch Cable

- Connecting Cable

D. Test Results Submittal

Prior to installing any equipment perform a radio path Site Survey test and submit results of survey for approval.

927.2 Materials

927.2.01 Delivery, Storage, and Handling

A. State-supplied Equipment

For projects where wireless equipment is to be supplied by the Georgia Department of Transportation, obtain State-supplied equipment from the Traffic Signal Electrical Facility (TSEF):

1. Contact the Engineer by phone or correspondence within one week after receiving the Notice to Proceed and arrange for a location to pick up the signal equipment.
2. Sign GDOT's Warehouse Issue Request Form 592 to accept delivery of the State-supplied equipment from GDOT's Traffic Signal Equipment Warehouse. Initial Form 592 if equipment is received from a GDOT District Field Office.
3. Inspect the equipment to ensure that it is operating properly and perform any operational tests within ten (10) calendar days after receiving the equipment.
4. Before installation, and within ten (10) calendar days, certify to the Engineer in writing that the State-supplied equipment was received in good condition.
5. Notify the Engineer in writing if the State-supplied equipment is defective. The State Signal Engineer will replace the defective State-supplied equipment.
6. If no written dissent is received after ten (10) calendar days or if equipment is installed in the field, the Engineer will consider this equipment to be satisfactory and accepted.
7. The Contractor shall supply new equipment to replace State-supplied equipment that is damaged by the Contractor.

B. Wireless Communications Equipment

See Section 926 for wireless communications equipment specifications.

The wireless communications equipment, components, supplies, or materials used in the installation may be sampled and tested if not previously approved by the Department.

Test according to the Specifications and the Sampling, Testing, and Inspection Manual using one or more of the following methods:

- Have the Department use their own facilities.
- Have the supplier or manufacturer use their facilities with an authorized Department representative to witness the testing.
- Provide independent laboratory test results indicating compliance with Department Specifications referenced in Subsection 602.1.02, "Related References", of this document.
- When testing by the Department is required, supply the item to the Department. Acceptance of materials tested does not waive warranties and guarantees required by the Specifications.

C. Cables

Use cable conforming to Section 680, Section 925, and the appropriate IMSA, NEMA, or UL Specifications for the wire or cable.

Obtain pole attachment permits required by local utility companies or pole owners to allow joint use for signal cable, hardware, or other auxiliary devices.

927.3 Construction Requirements

Refer to Subsection 107.07 of the Specifications regarding proper conduct of The Work.

927.3.01 Personnel

For the definition of a qualified electrician, see Subsection 755.1.01.

927.3.02 Equipment

Use machinery such as trucks, derricks, bucket vehicles, saws, trenchers, and other equipment necessary for the work and approved by the Engineer prior to installation operations.

927.3.03 Preparation

Utility Permits

A. Application

Apply for, obtain, and pay for utility services and pole attachment permits for wireless communications operation required in the Plans or required when the site survey is completed.

B. Maintenance

Maintain these utility services until Final Acceptance of each installation. After Final Acceptance, transfer these services and permits to the local government or jurisdiction responsible for maintenance and operation. Ensure that the transfer does not interrupt service.

C. Utility Location

When installing aerial cable of any type, ensure that overhead clearance and separation requirements conform to local utility company standards the NEC and the NESC. Refer to the Standard Details Drawings for further information on utility clearances.

927.3.04 Fabrication

General Provisions 101 through 150.

927.3.05 Construction

A. Acquiring and Disposing of Equipment

Do not modify the signal equipment, design, and operation without the District Traffic Engineer's written approval.

All communications equipment removed or replaced shall be returned to District Traffic Signal Shops unless otherwise noted in the Plans or as directed by the Engineer.

B. Communications Equipment Modification and Removal

Upon modification of any existing communications equipment, responsibilities for maintenance, operations and response to communications malfunction become the responsibility of the contractor and provisions of Section 647.3.07, "Contractor Warranty and Maintenance", apply.

Remove existing communications equipment that is not used in the final installation when the new communications is operational.

Carefully remove equipment to minimize damage and retain it in its original form. This equipment may include:

- Fiber Modems
- 2070 7A Modules
- 2070 6B Modules
- Connecting Cables

C. Site Survey

Prior to installing any equipment perform a radio path Site Survey test. Ensure the test evaluates the Signal Strength (dBm), Fade Margin (dB), Signal-to-Noise Ratio, Data Integrity (poll test), and a complete frequency spectrum scan. Ensure the radio path site survey test is performed using the supplied brand of radio equipment to be deployed. During the initial radio path signal strength test it may be determined that a repeater station may be necessary to complete the intended link. Provide the test results to the Engineer for review and approval. Submit copies of the test results and colored copies of the frequency spectrum scan along with an electronic copy of this information. Final locations and type of antennas and any necessary repeater stations are to be approved by the Engineer. Upon completion of the project provide site survey kit and software to maintaining agency.

D. Antenna

Provide and install antenna in such a manner that avoids conflicts with other utilities (separation distances in accordance with the guidelines of the National Electrical Safety Code) and as specified in the antenna manufacturer's recommendations. Secure the antenna mounting hardware to the pole and route the coaxial cable such that no strain is placed on the coaxial connectors. On wood pole installations, bond the antenna mounting hardware to the pole ground using # 6 |AWG bare copper wire using split bolt or decompression type fitting.

E. Power Divider

Provide and install antenna power divider at locations determined by site survey to require two antennas. Provide power divider and cables in accordance with Section926. Ensure all weather exposed RF connectors are sealed with a self sealing rubberized tape.

F. Coaxial Cable

Provide and install Coaxial cable as specified in section 926. Do not exceed the 1 inch (25.4) bend radius of the coaxial cable as it transverses from the cabinet to the antenna assembly. Connect the lightning arrestor to the coaxial cable in the equipment cabinet.

G. Lightning Arrestor

Provide and install the lightning arrestor as specified in section 926. Properly ground and secure the arrestor in the cabinet.

H. Power & Cabling

Permanently label all cables in the cabinet. Ensure the power supply for the radio system is not connected to the GFCI receptacle circuitry located in the cabinet. Ensure the appropriate radio connecting cables, configuration cable and radio antenna patch cable are provided and installed correctly.

I. Self Contained Radio Cabinets

Provide and install any self contained radio cabinet units as shown on the plans or determined by the site survey. Provide radio cabinet units as specified in section 926. Install cabinet units at top of pole in accordance with utility locations and site survey. Provide electrical service to cabinet.

J. Documentation

Place a copy of all manufacturers' equipment specifications, instruction and maintenance manual in the equipment cabinet.

927.3.06 Quality Acceptance

Upon completion of the installation check to ensure that communications are established. If communications are not established, use configuration and diagnostic software to determine and correct the problem.

927.3.07 Contractor Warranty and Maintenance

A. Warranties

Provide manufacturer's warranties or guarantees on electrical, electronic, or mechanical equipment furnished, except state-supplied equipment.

Ensure that warranties and/or guarantees are consistent with those provided as customary trade and industry standard practices; or as otherwise specified in the Plans, Standard Specifications, or Special Provisions.

Upon Final Acceptance, transfer the manufacturer and Contractor warranties or guarantees to the Engineer. Ensure that warranties are continuous and state that they are subject to transfer.

Acceptance or approval of the Work does not waiver warranties or guarantees where required by the Specifications. Final Acceptance will not be granted until all warranties and guarantees are received.

B. Guaranties

Repair and/or replace all equipment and material supplied under these Contract Documents which has been determined by the Engineer to not meet Specifications.

The Engineer reserves the sole right to determine suitability or unsuitability of the supplied equipment and material. The contractor shall bear the total cost of delivery and transportation related to the repair and replacement of equipment and material throughout the duration of the Contract unless otherwise approved by the Engineer.

927.4 Measurement

Wireless Communications items complete, in place, and accepted of the kind, size, and type specified are measured as follows:

A. Shelf Mount Spread Spectrum Wireless Radio Transceiver Unit with FSK and RS 232 Connection

Shelf Mount Spread Spectrum Wireless Radio Transceiver Unit with FSK and RS 232 Connection are measured for payment by the actual number installed as complete functional and accepted. This item is to be supplied complete with power supply, power supply cable, configuration cable, antenna patch cable, antenna lightning arrestor, and appropriate connecting cable for communications with the device. There shall be no other separate cost to the department for supply, testing and installation of this item.

B. Shelf Mount Spread Spectrum Wireless Radio Transceiver Unit with RS 232 Connection

Shelf Mount Spread Spectrum Wireless Radio Transceiver Unit with RS 232 Connection are measured for payment by the actual number installed as complete functional and accepted. This item is to be supplied complete with power supply, power supply cable, configuration cable, Antenna patch cable, antenna lightning arrestor, and appropriate connecting cable for communications with the device. There shall be no other separate cost to the department for supply testing and installation of this item.

C. Rack Mount Spread Spectrum Wireless Radio Transceiver Unit with FSK and RS 232 Connection

Shelf Mount Spread Spectrum Wireless Radio Transceiver Unit with FSK and RS 232 Connection are measured for payment by the actual number installed as complete functional and accepted. This item is to be supplied complete with power supply, power supply cable, configuration cable, Antenna patch cable, antenna lightning arrestor, and appropriate connecting cable for communications with the device. There shall be no other separate cost to the department for supply, testing and installation of this item.

D. 2070 Mount Spread Spectrum Wireless Radio Transceiver Unit with RS 232 Connection

2070 Mount Spread Spectrum Wireless Radio Transceiver Unit with RS 232 Connection are measured for payment by the actual number installed as complete functional and accepted. This item is to be supplied complete with power supply, power supply cable, configuration cable, Antenna patch cable, antenna lightning arrestor, and appropriate connecting cable for communications with the device. There shall be no other separate cost to the department for supply, testing and installation of this item.

E. Self Contained Spread Spectrum Wireless Radio Repeater Station

Self Contained Spread Spectrum Wireless Radio Repeater Stations are measured for payment by the actual number installed as complete functional and accepted. This item is to be supplied complete with power supply, power supply cable, configuration cable, antenna lightning arrestor, antenna, mounting hardware, cabinet and appropriate connecting cable for extending the communications network. There shall be no other separate cost to the department for supply, testing and installation of this item.

F. Directional Radio Antenna (Yagi) and Connecting Cable

Directional Radio Antenna (Yagi) and connecting cable are measured for payment by the actual number of antennas installed as complete functional and accepted. This item is to be supplied complete with connecting cable and mounting hardware for the appropriate mounting. There shall be no other separate cost to the department for supply, testing and installation of this item.

G. Omni Directional Radio Antenna and Connecting Cable

Omni Directional Radio Antenna and connecting cable are measured for payment by the actual number of antennas installed as complete functional and accepted. This item is to be supplied complete with connecting cable and mounting hardware for the appropriate mounting. There shall be no other separate cost to the department for supply, testing and installation of this item.

H. Antenna Power Divider and Connecting Cables

Antenna Power Divider and connecting cables are measured for payment by the actual number of antenna power dividers installed as complete functional and accepted. This item is to be supplied complete with connecting cables. There shall be no other separate cost to the department for supply, testing and installation of this item.

I. Shelf Mount Spread Spectrum Wireless Radio Transceiver Unit with Ethernet Connection

Shelf Mount Spread Spectrum Wireless Radio Transceiver Units with Ethernet connection are measured for payment by the actual number installed as complete functional and accepted. This item is to be supplied complete with power supply, power supply cable, configuration cable, Antenna patch cable, antenna lightning arrestor, and appropriate connecting cable for communications with the device. There shall be no other separate cost to the department for supply and installation of this item.

J. Spread Spectrum Wireless Radio Survey

Spread Spectrum Wireless Radio Surveys are measured for payment by the actual number of radio installation surveys completed and accepted. There shall be no other separate cost to the department for conducting a site survey and completed report.

K. Spread Spectrum Wireless Training

Spread Spectrum Wireless Radio Training is measured as a lump sum for all supplies equipment, materials, handouts, travel and subsistence necessary to conduct the training.

927.4.01 Limits

Not Applicable.

927.5 Payment

Payment is full compensation for furnishing and installing the items complete in place according to this specification. Payment includes all compensation for furnishing labor, materials, tools, equipment, and incidentals required to complete the work.

No payment will be made for individual items unless a pay item is included in the plans for the specific item.

Payment will be made under:

Item No. 927	Shelf Mount Spread Spectrum Wireless Transceiver with FSK & RS 232 connection	Per each
Item No. 927	Shelf Mount Spread Spectrum Wireless Transceiver with RS 232 connection	Per each
Item No. 927	Rack Mount Spread Spectrum Wireless Transceiver with FSK & RS 232 connection	Per each
Item No. 927	2070 Mount Spread Spectrum Wireless Transceiver with RS 232 connection	Per each
Item No. 927	Self Contained Spread Spectrum Wireless Radio Repeater Station	Per each
Item No. 927	Directional Radio Antenna and Connecting Cable	Per each
Item No. 927	Omni Directional Radio Antenna and Connecting Cable	Per each
Item No. 927	Antenna Power Divider	Per each
Item No. 927	Spread Spectrum Wireless Radio Survey	Per each
Item No. 927	Spread Spectrum Wireless Training	Lump Sum

Office of Traffic Safety and Design

First Use Date: May 22, 2009

DEPARTMENT OF TRANSPORTATION

STATE OF GEORGIA

SPECIAL PROVISION

PROJECT NO.:

P.I. NO.:

Add the following:

Section 999— MISCELLANEOUS (Radar Speed Display Unit)

999.1 General Description

This work includes furnishing, maintaining, transporting, and using Trailer Mounted Radar Speed Display Unit (RSDU) according to these Specifications at locations shown on the Plans, in the Special Provisions, or as directed by the Engineer. This specification establishes the physical display and operational requirements for solar assisted and battery powered, Radar Speed Display Units used in active work zones to inform motorists of the posted speed and their actual speed.

999.1.01 Definitions

General Provisions 101 through 150.

999.1.02 Related References

A. Standard Specifications

General Provisions 101 through 150.

B. Referenced Documents

MUTCD

NCHRP 350

999.1.03 Submittals

General Provisions 101 through 150.

999.2 Materials

General Provisions 101 through 150.

999.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

999.3 Construction Requirements

999.3.01 Personnel

General Provisions 101 through 150.

999.3.02 Equipment

Ensure Trailer Mounted Radar Speed Display Unit (RSDU) equiment meets the following requirements:

A. The minimum requirements of the MUTCD and the crashworhty performance criteiria cointained in the National Cooperative Highway Research Program (NCHRP) Report 350.

B. May be either new or used provided the RSDU meets the requirements of this Subsection.

C. Ensure the Display Unit Panel and Housing meet the following physical requiremnets as a minimum:

1. Panel support structure capable of being raised and lowered, and when raised to the upright position, the maximum height to the top of the panel from the ground is eight (8) feet.
2. Provide capability to mount a standard 24 inch by 30 inch (609mm x762mm) regulatory sign with interchangeable numbers showing the posted speed limit above the message display.
3. Provide capability to mount a legend "YOUR SPEED" either above or below the message display.

D. Ensure the Message Display meets the following physical requirements as a minimum:

1. Provide a bright LED, two digit speed display on a flat black background with bright yellow LEDs.
2. Each digit contain either a seven-segment layout or matrix-style design. Each digit measure a minimum of eighteen (18) inches (457 mm) in height.
3. Speed display visible from a distance of at least one-half (1/2) mile (800 m) and legible from a distance of at least 650 ft (198m) during both daytime and nighttime operations.
4. Display shall adjust for day and night operation automatically with a photocell.
5. LED technology displaying oncoming vehicle speeds in miles per hour (MPH) from 10 MPH (16 km/h) to 99 MPH (159 km/h).
6. Equiped to alert motorist when they are traveling over the posted speed by flashing the traveling speed.
7. Covered by an Ultra Violet (UV) inhibited, clear, non-fading or clouding polycarbonate resin lens, a minimum of 0.25 inch (6.35 mm) in thickness that can be opened or removed for maintenance.

E. Provide solar powered units meeting the following criteria:.

1. The battery equiped with a battery controller to prevent over-charging and over dis-charging, and an external battery level indicator.
2. Unit equiped with a minimum of two, heavy duty, deep cycle batteries which shall power the unit 24 hours a day for a minimum of 12 days without assistance of the solar panel(s).
3. Unit equipped with solar panel(s) which generates sufficient power to enable the system to continually recharge the batteries.
4. The battery, controller and power panel designed to be protected from the elements and vandalism.

F. The radar unit shall not be affected by normal radio transmissions and meet the following physical requirements as a minimum:

1. The complete RSDU designed and certified to operate in ambient air temperatures ranging from –20 ^{o}F (-29 ^{o}C) to 140 ^{o}F (60 ^{o}C). The unit and its operation is not affected by adverse weather conditions.
2. Unit equipped with the manufacturers's radar device that measures speed in miles per hour.
3. Radar device detecting the speed of oncoming vehicles only from a minimum distance of one-quarter mile (4 km) and capable of accurately sensing speeds of 10 to 99 mph with over speed function that operates when a vehicle approaches over the posted speed limit.

G. The RSDU is entirely mounted on a trailer meeting all of the requirements of the Georgia Vehicle Code.

Additional trailer requirements:

1. The trailer and the components of the RSDU designed to allow one person to perform all transporting and operating functions without assistance.
2. The trailer designed for unlimited on-highway travel at 70 mph (110 kph).
3. The trailer has a minimum of four outrigger type leveling jacks, one at each corner of the trailer deck, and designed to be set up at the site with its own chassis and outriggers, without being hitched to a vehicle.
4. The jacks are mounted to allow them to swivel into a locked position for secure storage during travel.

5. The trailer and all mounted equipment are structurally adequate for unlimited normal operation in wind velocities up to 80 mph (130 kph).
6. Trailer height, in the travel position, be from a minimum of 40 inches (1.01m) to a maximum of 84 inches (2.13 m). When in travel position, the display panel shall fold down such that it is parallel to the ground to reduce wind resistance.
7. Trailer height, in the display position, be from a minimum of 82 inches (2.08 m) to a maximum of 122 inches (3.09 m) including the speed limit sign mounted on top of the display panel.
8. Trailer width be from a minimum of 48 inches (1.22m) to a maximum of of 72 inches (1.8m).
9. All mechanisms for raising and lowering the sign panel be enclosed to ensure safety and deter vandalism.
10. Trailer hitch having a lockable coupler.
11. Product safety plaques or decals be furnished and affixed at the operator's station and at any hazardous area.
12. The rear of the trailer be equipped with a red tail lamp, a red stop lamp, a turn indicator and a red reflector on each side at the same level and as widely spaced laterally as practicable.

999.3.03 Preparation

General Provisions 101 through 150.

999.3.04 Fabrication

General Provisions 101 through 150.

999.3.05 Construction

A. Utilization Requirements

1. When set up as a Pay Item in the Contract, utilize RSDU whenever any condition(s) exists that would require extra emphasis in warning motorists of posted speed limit or at any location as directed by the Engineer. Furnish RSDU and have them available on a continuous basis.
2. Locate the RSDU beyond the posted speed limit and prior to the the construction activity where conditions exists that would require extra emphasis in warning motorists of the posted speed limit. The location of the RSDU shall be approved by the engineer.
3. Include the location of the RSDU in the approved traffic control plan required in Section 150-Traffic Control.

B. Protection

Any RSDU in use that is not protected by positive barrier protection shall be delineated by a minimum of three drums that meet the requirement of Section 150.05.A.1. The drum spacing shall not exceed a maximum of ten (10') feet as shown in Detail 150-PCMS. When the RSDU is within twenty (20') feet of the opposing traffic flow, the trailing end of the RSDU shall be delineated with a minimum of three drums spaced in the same manner as the approach side of the RSDU.

When not in use the RSDU shall be removed from the roadway unless protected by positive barrier protection. If the RSDU is not in use and protected by positive barrier protection then the sign panel shall be turned away from traffic.

999.3.06 Quality Acceptance

General Provisions 101 through 150.

999.3.07 Contractor Warranty and Maintenance

Keep the units in good repair and neat and clean in appearance. If the unit fails, malfunctions, or is damaged, immediately repair the unit. Make repairs or replace the unit within 24 hours. Maintenance also includes periodically cleaning the units.

999.4 Measurement

Radar Speed Display Unit, complete with trailer, generating equipment, regulatory speed limit sign and 'Your Speed" legend are measured by the unit.

696.4.01 Limits

General Provisions 101 through 150.

999.5 Payment

Radar Speed Display Unit, complete with appurtenances, will be paid for at the Contract Unit Price Per Each. Payment is full compensation for furnishing, installing, operating, relocating, maintaining and removing the RSDU for the duration of The Work. Each RSDU will be paid for only one time. The RSDU will remain the property of the Contractor.

Payment will be made under:

Item No. 999	Radar Speed Display Unit	Per Each

999.5.01 Adjustments

General Provisions 101 through 150.

Office of Construction