

SECTION 02551

WATER MAINS

02551.01 GENERAL

A. Description

Water main installation shall include, but not necessarily be limited to, furnishing and installing water pipe, fittings, and appurtenances of the size and type shown on the Plans, installed on a firm foundation true to line and grade in accordance with the Contract Documents.

B. Related Work Included Elsewhere

1. Protection of the environment; Section 01500.
2. Trench excavation, backfill, and compaction; Section 02250.
3. Water valve and appurtenance installation; Section 02552.
4. Water service installation; Section 02553.
5. Fire hydrant installation; Section 02554.
6. Cast-in-place concrete; Section 03300.

C. Quality Assurance

1. Materials
 - a. The County Engineer will inspect all materials before and after installation to ensure compliance with the Contract Documents. When specific tests of materials are called for in the referenced standards and specifications, the County Engineer has the option of requiring that any or all of these tests be performed for materials furnished for a specific project. When testing is required, it will be specified herein or in the "Special Provisions."
 - b. Cast iron fittings and ductile iron pipe (DIP) and fittings shall be sound and without defects that might impair its service. Defective areas shall not exceed the maximum allowable minus wall thickness tolerance specified in AWWA C110 or C151. Repair of defects by welding or other methods will not be allowed. Defective or damaged lining areas may be repaired by cutting out the defective or damaged lining to the metal so that the edges of the lining not removed are perpendicular or slightly undercut. The cut-out area and the adjoining lining shall be thoroughly wetted, and a stiff mortar applied and troweled smooth with the adjoining lining. After any surface

water has evaporated, but while the patch is still moist, it shall be cured by the application of a seal coat.

DIP material shall be used for all potable water mains and all raw water mains located on the treatment site. It is the Contractors option to utilize this material for all raw water mains. If utilized for raw water the words "**RAW WELL WATER**" must be stencilled on the pipe in 2 inch block letters every 10 feet.

- c. Polyvinyl chloride (PVC) pipe and couplings shall be homogeneous throughout and free from visible cracks, bubbles, blisters, holes, foreign inclusions, cuts, or scrapes on inside or outside surfaces, or other imperfections which may impair the performance or life of the pipe. Each pipe shall be straight-to-within 1 1/4 inch per 20-foot length of pipe when uniformly supported along its entire length, and shall have a true circular cross-section to within $\pm 1/64$ inch. This pipe shall only be allowed in special applications of non potable/treated lines with prior County approval.

PVC material shall only be utilized for the transmission of raw well water, up to the treatment site, where ductile iron pipe shall be used. The words "**RAW WELL WATER**" must be stencilled on the pipe in 2 inch block letters every 10 feet. Bedding shall be done in accordance with the Standard Details. Tracer wire and marker tape shall be installed with this pipe material in accordance with Section 02551.02.C.7 and Section 02551.02.C.8.

2. Chlorination and Field Tests

- a. General

- 1) The Contractor shall furnish all labor, tools, materials, and equipment necessary to perform the tests specified and to chlorinate the water mains.
- 2) The Contractor shall schedule all tests with the County Engineer at least 48 hours in advance of the test, and shall conduct all acceptance testing in the presence of the County Engineer. The County will witness one test and perform one Substantial Completion Inspection and one Final Inspection at no cost to the Contractor. If the project is released for service following Substantial Completion acceptance tests, the County will perform a final inspection if required at no cost to the Contractor. Should the pipeline fail the first County witnessed test, the Contractor shall reimburse the County for all costs resulting from such additional tests so required until the pipeline passes the test(s). The Contractor shall also reimburse the County for the cost of inspection if the Contractor is not prepared for any test, additional retests, and additional Substantial Completions including Partial Substantial Completion Inspections or additional Final Inspections. Reimbursement shall be made prior to the next Substantial Completion or Final Inspection.
- 3) The section of water main shall be filled by a metered connection

from such existing fire hydrant or main as may be designated by the County Engineer. The Contractor shall furnish a backflow preventer ahead of the new water main. When charging and testing water mains which are not sufficiently close to existing water mains carrying County water to permit connection direct by pipe or hose lines, County approved tank wagons shall be used to haul water and serve as suction wells.

- 4) Any defective work which shows up while conducting tests or before substantial completion acceptance, and any leaks occurring after substantial completion acceptance but before final acceptance due to either blown joints or cracked pipe or fittings shall be replaced or repaired by the Contractor at the Contractor's expense. Should the work be done by the County in the case of an emergency, the Contractor shall reimburse the County for the actual cost of replacing such materials and making such installations.

b. Chlorination, Flushing, and Bacteriological Testing

- 1) When the water mains are completed, each section shall be chlorinated in accordance with AWWA C601 except as noted below. A solution of hypochlorite of lime shall be discharged into the water main, by means of continuous feed, near the point where the water main is being charged. This solution shall be of such strength and quantity as may be necessary to provide 50 parts per million residual chlorine after 24 hours, in the section of water main being charged.
- 2) After the 24 hour (minimum) disinfection period, the Contractor shall flush the water main until:
 - a) Turbidity is below 2 NTU, and
 - b) Chlorine level is at or below 2 ppm.
- 3) Samples shall be taken by a State certified sampler and tested by a State certified laboratory for bacteriological contamination at the expense of the Contractor. Should the chlorine residual and bacteriological analysis not be satisfactory, the Contractor shall flush and re-chlorinate the water main until satisfactory results are obtained. Samples shall be taken for every street, court or section. Each street, court, or section shall pass two consecutive tests, taken a minimum of 24 hours apart. Samples shall be taken in the presence of County Engineer.

c. Hydrostatic Testing

- 1) Water mains and appurtenances shall be hydrostatically tested by the Contractor in accordance with AWWA C600 and as specified herein.
- 2) The pressure in the water main shall be increased to 150 psi at the highest point of the section of main under test, provided the static pressure is under 100 psi. Where static pressure is over 100 psi, it

shall be noted in the "Special Provisions" and the test pressure shall then be 50 psi above static pressure. The test shall be a 3-hour duration. Allowable leakage shall be calculated using the following formula:

$$L = \frac{SD\sqrt{P}}{133,200}$$

L = Allowable leakage in gallons per hour

S = Length of pipe tested, in feet

D = Nominal diameter of pipe, in inches

P = Average test pressure, in pounds per square inch

Should the hydrostatic test show the water main is defective, the Contractor shall remedy such defects and retest the water main as specified above. This procedure shall be repeated until the test requirements are met.

d. Continuity Testing for PVC Pipe

After backfilling, the Contractor shall test the tracer wire to demonstrate electrical continuity between fire hydrants and through the length of the PVC pipeline installed. Any discontinuity shall be located, repaired, and retested at the Contractor's expense until continuity is achieved. Repairs shall be made utilizing the Scotch 3M82A kit with a mechanical splice union.

D. Submittals

1. Shop Drawings

Shop drawings shall be submitted as specified in the "General Provisions" for the following materials, and shall include the following information:

- a. Cast iron fittings and ductile iron pipe (DIP) and fittings: product information and dimensions; pressure rating or class; storage, handling, and installation recommendations.
- b. Polyvinyl chloride (PVC) pipe and couplings: product information and dimensions; pressure rating; storage, handling, and installation recommendations.
- c. Tie rods, retainer glands, and associated hardware: product information and dimensions; pressure rating; installation recommendations.

2. Certificates of Compliance

Certificate of compliance shall be submitted in accordance with the "General Provisions" for the following materials stating that item supplied is in accordance with the requirements specified herein:

- a. Cast iron fittings and ductile iron pipe and fittings
 - b. Polyvinyl chloride (PVC) pipe
3. Certified Test Results

Certified test results shall be submitted as specified in the "General Provisions" for the following:

- a. Cast iron fittings and ductile iron pipe and fittings.
- b. Polyvinyl chloride (PVC) pipe
 - 1) Prior to approval of finished pipe, the manufacturer shall submit Certified Material Test Reports for the following materials: aggregates, cement, admixtures, wire mesh, reinforcing rod, prestress wire, steel sheet, plate and shapes, joint rings, bolts, lugs and gaskets. Water for mortar and concrete mix shall be certified to have met the requirements of ASTM C-94. Certified Reports shall show the actual results of all required chemical analyses, physical tests, examinations and heat treatments, including times and temperatures.
 - 2) The manufacturer's control number or work order number pertaining to any given section of pipe shall be stamped on the spigot joint ring when production has begun and legibly and indelibly marked on the concrete interior of the pipe following curing. All inspection reports and production records shall show the work control number.

02551.02 MATERIALS

A. Materials Furnished by the County

1. The County will not furnish any materials for water main construction.
2. The Contractor may obtain potable water from the County's potable water system for testing water mains. The Contractor shall contact the Department of Fiscal Services, Billing Section, for requirements. A backflow prevention device must be placed in accordance with the Standard Details prior to drawing County water.

B. Contractor's Options

The Contractor may furnish any specified pipe material and compatible specified fittings of the Contractor's choice, for the uses noted in this specification, unless otherwise specified in the "SPECIAL PROVISIONS."

C. Detailed Material Requirements

1. Portland cement concrete for pipe fitting buttresses and anchorages shall be Mix No. 1 for unreinforced concrete buttresses and Mix No. 3 for reinforced concrete buttresses. Concrete mixes shall be as specified in Section 03310.02.

2. Polyvinyl chloride (PVC) Pipe and couplings shall be manufactured in accordance with AWWA C900 with DIP outside diameter, Table 2 dimensions, and 20 foot length as modified herein. Pipe shall have a dimension ratio (DR) of 18, pressure class of a minimum of 200 psi, and shall be furnished with rubber gasketed joints of either the integral thickened bell or twin gasketed coupling type. Pipe, gaskets, and gasket lubricant shall be suitable for potable water systems. Pipe and couplings shall be marked and factory tested in accordance with AWWA C900.
3. Cast Iron Fittings
 - a. All fittings shall be manufactured in accordance with AWWA C110. Fittings shall be designed and constructed to withstand a pressure not less than that for the adjacent pipe or as follows, whichever is greater: fittings shall have a minimum pressure rating of 200 psi.
 - b. All fittings shall be cement-lined in accordance with AWWA C104, double thickness. This lining shall be sealed with bituminous seal coat. The outside surface shall be bituminous coated.
4. Ductile Iron Pipe and Fittings
 - a. Pipe
 - 1) Pipe shall be manufactured in accordance with the requirements of AWWA C151 except that the metal thickness shall be as described herein. Pipe nominal lengths may be 16 through 20 feet.
 - 2) All pipe and fittings shall be designed and constructed to withstand all external pressure caused by overburden as indicated on the profile and traffic loads to which the pipe may be subjected.
 - 3) All ductile iron pipe will be designed for a minimum of 350 psi working pressure and Type 1 laying condition. The minimum thickness shall be Class 50 or as shown on the Plans or specified in the "Special Provisions".
 - b. Joints

Joints may be mechanical or rubber gasketed push-on type. Unless otherwise noted, all joints shall be in accordance with AWWA C111.
 - c. Fittings
 - 1) All fittings shall be manufactured in accordance with AWWA C110 or AWWA C 153 for compact fittings sizes 3 inch through 16 inch. Fittings shall be designed and constructed to withstand a pressure not less than that for the adjacent pipe.
 - 2) Fittings shall be designed and constructed to withstand a pressure not less than that for the adjacent pipe or as follows, whichever is greater: fittings shall have a minimum pressure rating of 200 psi.

d. Lining and Coating

All pipe and fittings shall be cement-lined in accordance with AWWA C104, double thickness. This lining shall be sealed with a bituminous seal coat. The outside surface shall be bituminous coated.

5. Joint Restraint

a. Restrained joint pipe and fittings shall be of the pipe manufacturer's standard design for prestressed concrete pressure, ductile iron, and steel pipe and fittings.

b. Ductile iron retainer glands for use with mechanical type joints shall be furnished with hardened set screws and the completed restrained joint assembly shall have a rated minimum working pressure of 200 psi. All mechanical restrained joints shall be utilized in accordance with the manufactures recommendations.

c. Ductile iron TYTON JOINT for use with rubber gasketed push on type joint (Field Lok 350 Gasket or approved equivalent) shall be used only on straight run buried pipe, not on mechanical joints, this joints shall be marked properly so it can be identified easily. The complete restrained joint assembly shall be rated 350 psi in accordance with the performance requirement of ANSI/AWWA C111/A21.11. All rubber gasketed push on type restrained joints should only be provided by manufacturer or suppliers who are authorized and licensed by the manufacture and they should be designed applied handled and installed in strict accordance with DIPRA and the pipe manufacturer's recommendations.

d. Rod for tie rod assemblies shall meet the material requirements of ASTM A 193, Grade B7, and shall be threaded for at least 8 inches on both ends. Rod shall be 3/4 inch diameter unless otherwise noted. Nuts shall meet the requirements of ASTM A 194. Manufactured tie rod and accessories shall result in the completed restrained joint assembly having a minimum working pressure rating of 200 psi.

6. Protective Coating

Field applied protective coating for under ground applications shall be a bituminous coating meeting the requirements of Section 09900.02, Article C, Paragraph 8.

7. Tracer Wire for Non-Metallic Pipelines

Tracer Wire shall be AWG No. 4 insulated stranded Copper.

8. Marker Tape for Non-Metallic Pipelines

Marker Tape shall be minimum 2-inches wide blue plastic tape with metallic lining or coating lettered "WATER" in black graphics.

02551.03 EXECUTION**A. Preparation**

1. Trench excavation, backfill, and compaction, and pipe bedding and haunching shall be as specified in Section 02250.03.
2. The pipeline trench excavation shall be dewatered sufficiently to allow pipe joints to be made under dry conditions. No joint shall be made under water.
3. No pipe shall be laid upon a foundation into which frost has penetrated, nor at any time when there is danger of ice formation or frost penetration at the bottom of the excavation. In freezing weather, open trench length shall be kept to a minimum and the excavation promptly backfilled after the pipe has been installed.
4. Each pipe shall be bedded on a solid foundation acceptable to the County Engineer. Bell holes shall be dug sufficiently large to insure that joints are properly made and the pipe is firmly bedded for the full length of the barrel.

B. Pipe Installation

1. All pipe shall be installed in accordance with the recommendations of the pipe manufacturer and as specified herein. These recommendations shall include maximum trench width, if more restrictive than that shown in the Standard Details; bedding requirements; backfill material and compaction, where applicable. In addition, the following shall apply unless otherwise noted:
 - a. Polyvinyl chloride (PVC) pipe shall be installed in accordance with the Standard Water and Sewer Details.
 - b. Cast iron fittings and ductile iron pipe (DIP) and fittings shall be installed in accordance with the Standard Water and Sewer Details and the recommendations of the Ductile Iron Pipe Research Association.
2. Proper and suitable tools and appliances for safe and convenient handling and joining of pipes and fittings shall be used. Slings shall not damage the exteriors and/or coating of the pipe, and shall be wide canvas or rubber-coated belts.
3. Pipe and fittings shall be carefully handled and lowered into the trench. Pipe shall be installed with special care to insure that each length abut against the next to produce no shoulder or unevenness of any kind along the inside bottom half of the pipeline. No wedging or blocking will be permitted in installing any pipe unless directed by written order or permission in writing is obtained from the County Engineer.
4. No pipe shall be brought into position until the preceding length has been thoroughly bedded and secured in place. Care shall be used to secure watertightness and prevent damage to, or disturbing of, the joints during the refilling process. After pipes have been installed and joints have been made, there shall be no walking on or working over the pipe, except as may be necessary in tamping the backfill material, until the backfill is at least 2 feet over the top of the

pipe.

5. The pipes shall be thoroughly cleaned before being installed and shall be kept clean until acceptance of the completed work. Open ends of all pipelines shall be provided with a stopper carefully fitted to keep dirt and other substances from entering. This stopper shall be kept in the end of the pipeline at all times when installation is not in progress.
6. Whenever a pipe requires cutting, to fit into the line or bring it to the required location, the work shall be done in a manner that leaves a smooth, square end.
 - a. Cut PVC pipe ends shall have burrs removed and the end beveled to match factory bevel. Field spigots shall be stop-marked with a felt tip marker or wax crayon for the proper length of assembly insertion.
 - b. Any lining damaged due to field cutting shall be repaired by the Contractor as specified herein.
7. In addition to the other requirements specified herein, when installing PVC water mains, the Contractor shall also furnish and install the following:
 - a. A copper tracer wire located on the left side, looking up station, and in the gravel bedding for the pipe. The wire shall be continuous in length with no breaks. The wire shall be laid with all mainline piping including stubs and fire hydrant laterals and shall be attached to the pipe at the most remote valve locations at all ends of the main. Connections to existing tracer wire or splicing of wire shall be accomplished via wire nuts rated for the gauge wire used and wrapped in electrical tape.
 - b. A minimum 2-inch wide blue marker tape shall be located in the trench, two (2) feet, ± 0.5 feet, above the pipe along the length of all mainline piping including all stubs and fire hydrant laterals.
8. Minimum Pipe Cover and Clearances
 - a. Water mains shall have no less than 42 inches of cover measured from the existing and/or established grade to the top of the pipe whichever is lower, except as noted on the Plans. When crossing sub-surface obstructions, 12 inch minimum clearance shall be maintained between the pipe and the obstruction.
 - b. When crossing sanitary sewers, water pipe sections shall be centered over the sewer so that joints on both sides are the maximum distance from the sewer.
9. Jointing Pipe
 - a. General

Before any joints are made in the trench, the Contractor shall demonstrate to the County Engineer by making a sample joint that methods the Contractor will employ conform with the Specifications, will secure a wa-

tertight joint, and that the workmen whom the Contractor intends to use for this work are familiar with the requirements for making proper joints.

b. Push-On Gasketed Joints

Prior to making gasketed joints, both mating pipe ends and the gasket shall be cleaned of all foreign material. The gasket shall then be inserted in or stretched over the cleaned gasket seat and lubricant applied to the gasket and the mating pipe end. The pipe ends shall be carefully aligned and then driven home. The driving method shall be approved by the County Engineer.

c. Mechanical Joints

A cast iron gland shall be positioned on the spigot end of the pipe, followed by a rubber gasket thoroughly lubricated with its tapered side facing the bell. The spigot shall then be inserted fully into the bell. The rubber gasket shall then be moved into position by hand until it is flush with the face of the bell. The gland shall then be placed against the face of the rubber gasket and the bolts inserted and made finger tight. Bolts shall be drawn up evenly on alternate sides beginning at the top, keeping the gland parallel to the face of the bell at all times. All nuts shall be tightened uniformly with a torque in accordance with the manufacturer's recommendations.

d. Other methods of jointing pipe will be given consideration by the County Engineer, provided the Contractor furnishes evidence that the proposed method is equal to or better than the specified methods, and further, provided that the proposed method has been successfully used and that the joint has previously been manufactured by the company from whom the Contractor proposes to purchase pipe.

10. Restrained joints and joint restraint systems shall be assembled in accordance with the system manufacturer's recommendations. Tie rod nuts shall be tightened by hand and then tightened one additional turn by wrench. Joint restraint systems shall be field protective coated with two coats of a bituminous coating after assembly.
11. Connections to existing work shall be made by the Contractor in the presence of the County Engineer at such a time and in such manner as directed and approved by the County Engineer. The Contractor shall submit to the County Engineer, for review and approval, a schedule for any proposed system disruption along with a draft letter of notice to the effected customers. Upon approval by the County Engineer, the Contractor shall notify, in writing, the customers in the area to be effected by the shut-off. All valves necessary for making connections will be operated by the County. The Contractor shall complete the connections with the greatest possible speed and all work will proceed without interruption until the existing system is returned to operation, so that the public will be inconvenienced as little as possible. When specified in the "Special Provisions," the Contractor shall make connections at night. When a tapping sleeve and valve is to be used for making the connection, the Contractor shall not proceed with the installation until directed to do so by the County Engineer. The tapping sleeve and valve shall be prepared in accordance with Section 02552.03. Where it is necessary to remove an existing buttress to make a connection, the removal shall be done by the Contractor without additional compensation therefore.

12. Buttresses and anchorages shall be installed at all caps, horizontal bends, tees, hydrants, branches, and beneath all vertical bends. Buttresses and anchorages shall be of concrete or concrete and steel. Buttresses and anchorages shall extend to solid, undisturbed soil and shall be constructed in accordance with the Standard Details, as shown on the Plans, or as directed by the County Engineer.
13. All buried metal pipe and/or appurtenance that do not have factory applied protective coating or whose coatings have been damaged shall be field coated with two coats of a bituminous coating after installation.

02551.04 METHOD OF MEASUREMENT**A. Water Mains**

RESERVED FOR FUTURE USE

B. Fire Hydrant Connections

RESERVED FOR FUTURE USE

02551.05 BASIS OF PAYMENT**A. GENERAL**

RESERVED FOR FUTURE USE

B. Water Mains

RESERVED FOR FUTURE USE

C. Fire Hydrant Connections

RESERVED FOR FUTURE USE

D. Valves and Fire Hydrants

RESERVED FOR FUTURE USE

SECTION 02552

WATER VALVES AND APPURTENANCES

02552.01 GENERAL

A. Description

Water valve and appurtenance installation shall include, but not necessarily be limited to, furnishing and installing gate, butterfly, and air release and vacuum valves or assemblies with appurtenant valve vaults or roadway valve boxes and accessories in accordance with the Contract Documents.

B. Related Work Included Elsewhere

1. Trench excavation, backfill, and compaction; Section 02250.
2. Water main installation and chlorination; Section 02551.
3. Cast-in-place concrete; Section 03300.
4. Precast concrete utility structure installation; Section 03400.
5. Brickwork, unit masonry; Section 04200.

C. Quality Assurance

1. Materials

The Engineer will inspect all materials before and after installation to insure compliance with the Contract Documents.

2. Field Tests

- a. Water valves and appurtenances installed at the same time as a new water main shall be tested, after installation, by the Contractor along with the water main in accordance with Section 02551.01.
- b. Water valves and appurtenances installed in an existing water main will be visually inspected for leakage by the County Engineer at the existing water main line pressure before the excavation is backfilled. The valve and joints shall be leak free under line pressure.
- c. Tapping sleeves and valves shall be tested after assembly on the existing water main but prior to making the tap. The Contractor shall pressurize the complete assembly to 150 psi, unless otherwise noted. The County

Engineer will visually inspect the tapping sleeve and valve for leakage. No leakage will be permitted.

D. Submittals**1. Shop Drawings**

Shop drawings shall be submitted as specified in the "General Provisions" for all valves furnished, and shall include the following information: product description; pressure, torque, or other operating ratings when specified; parts and materials list; detailed assembly drawings; direction of opening; and maintenance requirements and procedures.

2. Certificates of Compliance

Certificates of compliance shall be submitted as specified in the "General Provisions" for all gate and butterfly valves stating the valve and all materials used in its construction conform to the applicable requirements of the following AWWA standards as modified herein:

- a. Gate valves 3-inch through 16-inch diameter nominal pipe size, resilient wedge type AWWA C509. Valves exceeding 16-inch diameter shall be submitted to the county engineer for review and approval.
- b. Butterfly valves over 16-inch diameter nominal pipe size -AWWA C504.
- c. Interior coatings for resilient seated gate valves - AWWA C550.

02552.02 MATERIALS**A. Materials Furnished by the County**

The County will not furnish any water valve or appurtenances.

B. Contractor's Options

None.

C. Detailed Material Requirements

1. Washed gravel for dewatering and air release and vacuum valve manhole fill shall meet the gradation requirements of ASTM C33, Size number 67, as specified in Section 02621.02.
2. Ductile iron and concrete pressure fittings, shall be as specified in Section 02551.02.
3. Tapping saddles and corporation stops shall be as specified in Section 02553.02.
4. Portland cement concrete for miscellaneous valve appurtenances and cast-in-place vaults shall be the Mix Number indicated on the Standard Details and as specified in Section 03310.02.

5. Precast concrete vault and manhole sections and grade rings shall be as specified in Section 03400.02.
6. Brick for valve support and miscellaneous valve appurtenances shall be sewer brick as specified in Section 04200.02.
7. Mortar for brickwork shall be as specified in Section 04100.02.
8. Frames, covers, and steps shall be as specified in Section 05500.02. Covers shall be labeled "WATER".
9. Gate Valves

- a. General

Resilient Seated Gate Valves shall be manufactured and tested to the requirements of AWWA Standard C-509-87 and C-500-86 as applicable for a design working pressure of 250 P.S.I. This pressure rating shall be cast on the outside of the valve and resilient wedge type gate.

In addition to the requirements of the AWWA Standards, the valve shall meet the following specification:

- 1) Valve body, bonnet and rubber encapsulated gate shall be Ductile Iron conforming to ASTM A-536. Shell thickness of body and bonnet components shall conform to Table 2 Sec. 4.4 AWWA C-509. Valves shall have a non-rising stem, 2-inch square operating nut which shall turn left (counter-clockwise) to open. Valves shall be furnished with mechanical joint ends unless flanged or other type ends are indicated on the plans. Valves shall be vertical type unless otherwise approved, with o-ring stem seals without gearing or by-pass valves. Foot-pound torques shall not exceed TABLE I shown on the next page. So-called "Thinwall" valves, not included in this Standard, are not allowed.

TABLE I

RESILIENT SEAT VALVE OPERATING TORQUES

TORQUES SHOWN ARE VALVES BEFORE AND AFTER 1000 OPERATING CYCLES

4" Resilient Seat Valve					6" Resilient Seat Valve				8" Resilient Seat Valve			
TORQUE-FT LBS					TORQUE-FT LBS				TORQUE-FT LBS			
BEFORE		AFTER			BEFORE		AFTER		BEFORE		AFTER	
PSI	OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE
50	5	13	7	13	20	25			17	48	15	37
100	10	15	10	20	30	32			23	57	18	47
150	10	22	15	25	37	48			27	77	22	58
200	10	30	20	37	47	73			30	80	22	62
250	15	37	27	47	58	90			28	82	20	62

10" Resilient Seat Valve					12" Resilient Seat Valve				16" Resilient Seat Valve			
TORQUE-FT LBS					TORQUE-FT LBS				TORQUE-FT LBS			
BEFORE		AFTER			BEFORE		AFTER		BEFORE		AFTER	
PSI	OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE	OPEN	CLOSE
50	10	32	10	27	17	62	20	67	30	63	50	107
100	12	43	10	37	20	82	28	97	57	103	67	130
150	15	47	10	38	27	123	30	127	60	107	80	147
200	18	50	12	47	32	147	35	162	67	130	103	173
250	22	62	15	57	30	155	38	177	73	147	137	197

- 2) Valve body and bonnet shall be coated on all exterior and interior surfaces with a fusion bonded epoxy conforming to the requirements of AWWA Standard for Protective Epoxy Interior Coatings for Valves and Hydrants; C-550-90. Manufacturer shall certify that the coating will conform to following sections of the Standard:
 - A. Section 2-Materials. (Relating to the suitability of the coating for use in a potable water system).
 - B. Section 4-Tested and Inspection. (Relating to qualification and production testing).
 - 3) The valve shall be designed so that during operation, or cycling of the valve, there is no friction or abrasion or rubbing together of the gate and body that can wear away any rubber or epoxy and expose bare iron. Valve manufacturer shall provide evidence from an independent testing laboratory that its valve can operate through 1000 cycles or operation at 250 P.S.I. unbalanced closing pressure and flow to open discharge without causing damage to the epoxy coating in body and gate and/or rubber coating on gate.
 - 4) Gate shall be covered with rubber over all interior and exterior ferrous surfaces. The rubber shall be securely bonded to the gate body, including the part which houses the stem nut. The stem hole through the gate shall be full opening top to bottom, and shall also be covered with rubber.
 - 5) "O" ring stem seal shall be replaceable with the valve under pressure in the full-open position.
 - 6) Resilient seated tapping valves shall be furnished with the tapping flange having a raised face or lip designed to engage the correspondence recess in the tapping sleeve flange in accordance with MSS-SP60. Tapping valves without the raised face on the tapping flange are not permitted since they do not assure the proper alignment requirement to prevent damage by a misaligned shell cutter. The interior of the waterway in the body shall be a full opening and capable of passing a full sized shell cutter equal to the nominal diameter of the valve.
 - 7) In order to assure compliance with AWWA and other applicable standards, and access to manufacturing facilities for inspection purposes, and assure timely shipment and delivery, all valves must be manufactured, assembled and tested in plant located within the continental United States.
 - 8) Valves, 4 inch to 16 inch, shall be U.S. Pipe Metroseal 250 or County approved equal.
- b. Tapping Valves and Sleeves
- 1) Valves for tapping service shall meet all the requirements for gate

valves. In addition the body seat rings shall have clear inside openings sufficient to pass a cutter of full diameter and equal to the nominal size of the tapping valve. Tapping sleeves shall be iron body mechanical joint type. Tapping valves for ductile iron pipe shall have flange by mechanical type ends unless otherwise shown on the Plans. All tapping sleeves shall be furnished with an outlet for testing.

- 2) Stainless steel type tapping sleeve shall be Romac Stainless Steel tapping sleeve Model SST-III or county approved equal.
- c. Buried valves shall be furnished with an extension stem terminating 4 feet below finished grade in accordance with the Standard Water and Sewer Details.

10. Butterfly Valves

- a. Butterfly valves shall be manufactured in accordance with AWWA C504 as modified herein. Valves shall be Class 150B, suitable for direct burial, and designed for a differential pressure across the valve of 150 psi., and a minimum flow of 15 feet per second for opening and closing.
- b. Valves shall be furnished with mechanical joint ends unless otherwise noted in the Contract Documents. When flanged ends are specified, valves shall be of the short lay length configuration.
- c. Valves shall be furnished with a rubber seat, either in the body or on the disc, and a seat mating surface of alloy cast iron conforming to ASTM A 436, Type I, or 18-8 stainless steel, Type 304 or 316. Valves 24-inch diameter and larger shall have adjustable seats of a design that permits replacement in the field without removal of the valve from the line.
- d. Valve shafts shall be stainless steel or monel, and shall be horizontal when the valve is installed in the water main.
- e. Valve operators may be worm gear or traveling nut type with a 2-inch square operating nut which shall turn left (counterclockwise) to open. Operators shall be fully enclosed in a gasketed grease-filled enclosure suitable for direct burial, and shall withstand an input of 350 foot pounds to the nut at extreme operator position without damage.
- f. Buried valves shall be furnished with an extension stem terminating four (4) feet below finished grade in accordance with the Standard Water and Sewer Details. The operating nut shall be located in a standard valve box and shall include a sealed valve position indicator which shows valve position, and direction and number of turns to open or close the valve.

11. Air/Vacuum Release Valve

- a. The air/vacuum valve shall be of the type that automatically releases to atmosphere large amounts of air found in pipe lines during filling cycle and allows air into a line when it is being drained or when a vacuum occurs.

- b. The air/vacuum valve shall have a cast iron body and cast iron cover. The internal compound lever mechanism shall be stainless steel and all other internals including float shall be stainless steel to avoid galvanic action. The stainless steel float shall withstand a minimum pressure of 1,000 psi.
- c. All materials of construction shall be certified in writing to conform to ASTM specifications as follows:

<u>PART</u>	<u>MATERIAL</u>	<u>SPECIFICATION</u>
Body and Cover	Cast Iron	ASTM A48, Class 30
Internal Linkage	Stainless Steel	Series 300
Float & Internals	Stainless Steel	Series 300
Seat	Buna-N	
Exterior Paint	Phenolic Primer Red Oxide	FDA approved for potable water

- d. All internals shall be easily removed through the top cover without removing the main valve from the lines.
 - e. An isolating valve shall be installed between force main and air/vacuum release valve for maintenance.
 - f. Air/Vacuum release valve shall be installed in an easily accessible vault. Vault shall be adequately vented to meet air/vacuum release valve requirement.
 - g. The valve manufacturer shall furnish installation and maintenance instruction manuals with each valve.
 - h. Valve shall be APCO series 400 as manufactured by Valve Primer Corporation, Schaumburg, IL, Val-Matic Series #100 as manufactured by Val-Matic Valve and Manufacturing Corp. or County approved equal.
12. Sliding type roadway valve boxes and covers shall be made of gray iron conforming to the requirements of ASTM A 48, Class 30 B and shall meet the dimensional and marking requirements indicated on the Standard Details.

13. Miscellaneous Small Pipe and Appurtenances

When indicated on the Standard Details or the Plans, the following materials shall meet the material requirements of the referenced standards or specifications:

- a. Galvanized steel pipe - ASTM A 120, Schedule 40.
- b. Standard malleable iron fittings, galvanized - ASTM A 153, A 197.
- c. Brass pipe - ASTM B 43.

- d. Bronze gate valves - FSS WW-V-54c.
- 14. Valve extension stems shall be manufactured of cold-rolled steel and furnished with a 2-inch square nut.

02552.03 EXECUTION

A. General

- 1. Excavation, foundation preparation, backfill, and compaction shall be as specified in Section 02250.03.
- 2. Construction methods shall be in accordance with Section 02251.03.
- 3. Valves shall be restrained, supported, and strapped to tees, crosses, dead ends, stubs, or outlets in accordance with the Standard Details.

B. Buried Gate and Butterfly Valves

- 1. Buried gate and butterfly valves shall be installed in accordance with the Standard Details and at the locations shown on the Plans or as directed by the Engineer.
- 2. All gate valves 16-inch diameter and smaller and all butterfly valves shall be supported as shown in the Standard Details, and shall be installed with an adjustable roadway valve box.
- 3. Roadway valve boxes shall be set at right angles to the water main, centered and plumb over the valve operating nut. Backfill shall be compacted under and around valve boxes to insure that no vertical loads are transmitted to the valve operators. Valves box sections shall overlap a minimum of 6 inches.

C. Valves in Vaults or Manholes

Dewatering and air release and vacuum valves shall be installed in manholes in accordance with the Standard Details.

02552.04 METHOD OF MEASUREMENT

RESERVED FOR FUTURE USE

02552.05 BASIS OF PAYMENT

A. General

RESERVED FOR FUTURE USE

B. Water Valves

RESERVED FOR FUTURE USE

SECTION 02553

WATER SERVICES, WATER METER SETTINGS, AND VAULTS

02553.01 GENERAL

A. Description

Water services, water meter setting, and vault installation shall include, but not necessarily be limited to, furnishing and placing water services with appurtenant meter housings and connection to the water main in accordance with the Contract Documents.

B. Related Work Included Elsewhere

1. Trench excavation, backfill, and compaction; Section 02250.
2. Water main installation and chlorination; Section 02551.
3. Water valve and appurtenance installation; Section 02552.
4. Cast-in-place concrete; Section 03300.
5. Precast concrete utility structure installation; Section 03400.

C. Quality Assurance

1. Materials

The County Engineer will inspect all materials before and after installation to ensure compliance with the Contract Documents.

2. Field Tests

Water services and water meter settings will be visually inspected for leakage by the County Engineer at the existing water main line pressure before the excavation is backfilled. The corporation stop, service laterals and valves shall be tested in accordance with the water main at 150 psi. Meter settings, piping, and connections shall be leak free under line pressure.

D. Submittals

1. Shop Drawings

Shop drawings shall be submitted as specified in the "General Provisions" for the following materials, and include the following information:

- a. Aluminum access hatches: product description, parts and materials list, and load rating.
- b. Water meters larger than 2-inch and 5/8-inch to 2-inch meter setting appurtenances: materials list naming manufacturer, model number, and any applicable options specified herein.
- c. Couplings for 3-inch or larger meter settings: product description and parts and materials list.

2. Certificates of Compliance

Certificates of compliance shall be submitted as specified in the "General Provisions" for the following:

- a. Contractor furnished meters: stating the manufacturer has tested the meter for accuracy of registration and that it complies with the accuracy requirements of the applicable AWWA standard.
- b. Polyethylene tubing: stating that all materials comply with the requirements of AWWA C901 as modified herein.

02553.02 MATERIALS**A. Materials Furnished by the County**

1. The County will furnish and install meters for all services requiring 5/8-inch through 1-inch meters. The County will furnish for installation, only to a master plumber, meter bottoms in excess of 1 inch with the meter head set by the County.
2. The master plumber will furnish and install meter appurtenances for all water service connections.

B. Contractor's Options

1. The Contractor may furnish precast concrete or plastic water meter vaults for 5/8-inch (single and twin meter settings) through 1-inch water services.

C. Detailed Material Requirements

1. Water Meters
 - a. Water meters for water service shall be Badger or other County acceptable meters only.
 - b. Inside water meters or in-ground water meters will be used for commercial and industrial services.
 - c. In-ground water meters will be the only approved meter to be used for residential services.
 - d. In-ground water meter vaults will be installed at the property line or easement line as specified in the Standard Details.
 - e. In-ground water meter vaults shall not be installed in sidewalks, driveways, traffic areas, paved areas, areas where access to the meters can be restricted by shrubbery, vehicles, fences, or equipment.
 - f. In-ground water meter covers: All covers shall be Ford Company electronic meter cover with removable plug or County approved equal, as specified in the Standard Details.

2. Water Service
 - a. Water services for 1-inch through 2-inch shall be Copper tubing Type K, annealed, and shall meet the material, chemical, and mechanical requirements of ASTM B 88.
 - b. Minimum single domestic water service size shall be 1-inch.
 - c. Single domestic water services in length of 100 feet to 850 feet, as measured from the main to the dwelling, shall be 1-½ inches in size.
 - d. Single domestic water services in excess of 850 feet shall be 2-inches in size.
 - e. All other water service connections shall be submitted to the County Engineer for approval.
3. Service pipes and fittings 3-inch diameter and larger for water shall be as specified in Section 02551.02.
4. Gate valves, roadway valve boxes, and tapping sleeves for water services shall be as specified in Section 02552.02.
5. Pipe for meter support in 2-inch metered water supplies shall be galvanized steel as specified in Section 02552.02.
6. Corporation stops with flared coupling nuts shall be Mueller Catalog Number H-15000, or County approved equal.
7. Copper tube couplings shall be flared type per Mueller Catalog Number H- 15400, or County approved equal.
8. Meter settings
 - a. Outside setting - All fittings, yokes, appurtenances, dual check valves, pressure reducing valves, backflow preventors, shall be manufactured by the Ford Company, provided and installed by a master plumber and as specified in the Standard Details.

Inlet service line, angle valve, meter vault, lids and covers shall be provided and installed by the contractor as specified in the Standard Details.
 - b. Inside setting - All yokes, fittings, isolation valves, pressure reducing valves, backflow preventors, appurtenances, and wire to be provided by the plumber and set per the Standard Details. Yokes shall be compatible with and capable of accepting current Badger or other County acceptable meter models used by the County.

Fittings, yokes, and appurtenances for 5/8 through 2-inch metered water supplies, including dual angle check valves, shall be manufactured by the Ford Meter Box Company. The meter fittings and the meter pit frames, lids, and covers shall be as specified on the Standard Details.

- c. Reduced Pressure Zone Backflow Preventer (RPZBP) will be required for all Commercial and Industrial services. It is prohibited to install RPZBP's in vaults below ground. Flooding of the vault can result in cross connection contamination. The RPZBP is to be installed inside the building in the mechanical room with a drain on the floor. If a RPZBP has to be installed outside, it must be located above ground and insulated to prevent freezing per the manufacturers recommendations. The location of RPZBP shall allow no obstacles or enclosures to prohibit County access, operation or maintenance.

- 9. Aluminum access hatches for 3-inch or larger meter vaults shall be designed to withstand a live load of 300 pounds per square foot or a H-20 wheel load. Door leaf shall be 1/4-inch aluminum diamond or safety tread pattern plate. Channel frame shall be 1/4-inch aluminum with concrete anchor flange around the perimeter, bituminous coated where in contact with concrete, and a 1/2-inch drainage coupling. Doors shall be equipped with brass hinges, stainless steel pins, spring operators, and an automatic hold-open arm with release handle. The door shall have a snap lock with a removable handle. The door shall be operable by a force not to exceed 30 pounds. Access hatches shall be Bilco model J-4AL, or County approved equal.

- 10. Pipe couplings for 3-inch or larger meter settings shall be a gasketed, sleeve-type. Couplings shall consist of one steel middle ring, two steel followers, two rubber-compounded wedge section gaskets suitable for use with potable water, and sufficient track-head steel bolts to compress the gaskets. Couplings shall be factory coated with rust inhibitive paint.

- 11. Tapping saddles shall be manufactured of high tensile ductile iron, ASTM A 536, protected with a fusion applied epoxy coating. Saddles shall be furnished with stainless steel straps, with a minimum 2 1/2-inch wide bearing area, and a rubber gasket suitable for potable water.

- 12. Portland cement concrete for cast-in-place meter vault lids and bases shall be Mix No. 3 as specified in Section 03310.

- 13. Concrete reinforcement shall be as specified in Section 03200.02.

- 14. Premolded asphalt joint for pipe wall penetrations shall be as specified in Section 03300.02.

- 15. Precast meter vaults shall be precast concrete vaults of the size indicated on the Standard Details furnished and installed as specified in Section 03400.

- 16. Round prefabricated polyvinyl chloride (PVC) plastic water meter vaults shall be used in high groundwater locations in lieu of precast meter vaults outside of traffic bearing areas. They shall be manufactured by the Mueller Company for the following sizes:

5/8 & 3/4-inch service with single meter	15-inch diameter vault (Model 250CS 1536LA)
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5/8 & 3/4-inch service with twin meters	18-inch diameter vault (Model 250 CD 1836LA)
1-inch service with single meter	18-inch diameter vault (Model 330 CS 1836 LA)
1-1/2 inch service and above	submit shop drawings to County Engineer for approval

The prefabricated meter vaults shall also comply with the following:

- a. Prefabricated water meter vaults shall be furnished with a standard Charles County Meter Frame and Cover as shown on the Standard Details.
 - b. The meter setting shall be furnished with a bleed valve on the outlet side of the setting.
 - c. The angle meter valve and angle meter coupling shall be as shown on the Standard Detail to assure interchangeability of County standard meters.
 - d. The meter yoke will not be required for prefabricated meter vaults using a rigid moveable internal platform which permits the meter to be raised to the surface for reading and servicing without disconnecting any piping.
17. Brick and concrete masonry units for meter vaults shall be as specified in Section 04200.02.

02553.03 EXECUTION

A. Water Services, Water Meter Settings, and Vaults

Water services, water meter settings, and vaults shall be installed in accordance with the requirements for the specific materials indicated above, in accordance with the Contract Documents, and the following:

1. Water services shall be jacked or driven under paving unless otherwise directed by the Engineer. Where open cutting is authorized, trench widths shall not exceed 24 inches. Water services installed in areas other than paving areas may be open cut or driven at the Contractor's option.
2. All services shall be laid to the grade and lines in accordance with the Contract Documents or as directed by the County Engineer.
3. All meter vaults shall be set at the location, and constructed of the materials shown in the Contract Documents.
4. Special care shall be taken to insure that the services are well bedded on a solid foundation. Any defects resulting from settlement shall be repaired by the Contractor at the Contractor's expense. All meter vaults shall be bedded on firm undisturbed earth. The pipe and fittings shall be thoroughly cleaned before being installed, and shall be kept clean until the acceptance of the complete work.

5. All services shall be thoroughly flushed with potable water. Services larger than 2-inch diameter shall be chlorinated as specified in Section 02551.
6. Water services shall be constructed only to those existing houses shown on the Plans or as directed by the County Engineer. All service ends not immediately connected to house service shall be provided with a cap to prevent any foreign matter from entering the pipe. Crimping of service ends will not be allowed.
7. Meter settings shall be level and the long axis of the setting shall be perpendicular to the proposed curb and gutter or edge of pavement in the case of open section roadways. Where the setting is remote from the roadway the long axis of the meter setting shall be aligned with the center line of the water service.

B. Connections to Water Mains

1. Service connections to existing water mains shall be made with tapping saddles or sleeves except for connections 1-inch and less to ductile or cast iron pipe which may be made by direct tap. Direct taps larger than 1-inch to ductile or cast iron pipe shall be allowed only where authorized by the County Engineer.
2. Service connections to new water mains shall be made by direct tapping ductile iron water mains for up to 1-inch services only, by installing appropriate outlet fittings and valves as the water main is being constructed, or by installing tapping saddles, tees, or sleeves.
3. Corporation taps or tapping sleeves and service laterals with curb stops shall be installed on new water mains before the water mains have been chlorinated and tested in accordance with the Specifications.

02553.04 METHOD OF MEASUREMENT

RESERVED FOR FUTURE USE

02553.05 BASIS OF PAYMENT

A. General

RESERVED FOR FUTURE USE

B. Water Services

RESERVED FOR FUTURE USE

C. Meter Settings and Vaults

RESERVED FOR FUTURE USE

D. Meter Relocation

RESERVED FOR FUTURE USE

SECTION 02554

FIRE HYDRANTS

02554.01 GENERAL

A. Description

Fire hydrant installation shall include, but not necessarily be limited to, furnishing and installing fire hydrants or relocating fire hydrants in accordance with the Contract Documents.

B. Related Work Included Elsewhere

1. Trench excavation, backfill, and compaction; Section 02250.
2. Water pipe, fitting, and appurtenance installation; Section 02551.
3. Water valve and appurtenance installation; Section 02552.

C. Quality Assurance

1. Materials

The Engineer will inspect all materials before and after installation to ensure compliance with the Contract Documents.

2. Field Tests

- a. Fire hydrants installed at the same time as a new water main shall be tested, after installation, by the Contractor along with the water main in accordance with Section 02551.01.
- b. Fire hydrants installed on an existing water main will be visually inspected for leakage by the Engineer at the existing water main line pressure before the excavation is backfilled. The hydrant, valve, and connecting pipe shall be leak free under line pressure.

D. Submittals

Shop drawings shall be submitted as specified in the "General Provisions" for the fire hydrants furnished and shall include the following information: product description, parts list, valve and hose connection sizes, operating nut style, and direction of opening.

02554.02 MATERIALS

A. Materials Furnished by the County

The County will not furnish any materials for fire hydrant installation or relocation.

B. Contractor's Options

The Contractor may furnish fire hydrants manufactured by Kennedy Valve, Model K-81-A; Mueller, Centurian; Waterous; or U.S. Pipe.

C. Fire Hydrants

1. Hydrant valve opening shall be a minimum of a 5-1/4-inch diameter main valve opening. Inlet connection shall be 6-inch mechanical joint with accessories (glands, plain rubber gaskets, bolts and nuts).
 2. Hose connections shall consist of two 2 1/2-inch diameter hose connections and one 4 1/2-inch diameter steamer or pumper connection threaded as follows: the 2 1/2-inch nose nozzles and 4-1/2 inch steamer nozzle shall have National Standard threads.
 3. Operating nut shall be 5 sided, 1 5/16 inches from point to flat, and shall turn left (counterclockwise) to open.
 4. Outer casing shall be one-piece cast iron, designed to permit its extension without excavating.
 5. Hydrant design shall be such that when the barrel is broken, it may be replaced without excavating or breaking adjacent pavement; that the entire barrel, including all working parts along with the main and waste valve seats, may be removed for inspection or repair without excavating or disturbing the ground; and that underground flanges with bolts and nuts are eliminated.
 6. The main valve seal shall be compression type sealing against a bronze seat and the valve shall open against pressure.
 7. Between elbow and top cap, the barrel shall be made in two parts connected by a swivel segment to permit facing the nozzles in any direction.
 8. Bonnet shall be bolted to the standpipe and shall have cast on the top an arrow and the word "Open" indicating the direction for opening.
 9. Bonnet construction shall utilize a one piece construction that isolates the stem's operating threads from the wet portion of the barrel. The internal portion of the bonnet shall be factory filled with grease to lubricate the operating threads. O-rings shall be provided where the stem penetrates the bonnet to prevent water from entering the grease cavity and to prevent exfiltration of the lubricant.
 10. A self opening drain valve shall be provided.
- D.** Gravel or crushed stone for hydrant foundation shall meet the gradation requirements of ASTM-C33/#67.
- E.** Retainer glands or tie rods and appurtenances for fire hydrant restraint, and pipe caps and

FIRE HYDRANTS

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plugs for existing fire hydrant lead abandonment shall be as specified in Section 02551.02.

- F. Portland cement concrete for hydrant and cap blocking shall be Mix No. 1 as specified in Section 03310.02.

02554.03 EXECUTION

A. General

1. Excavation, foundation preparation, backfill, and compaction shall be as specified in Section 02250.03.
2. Construction methods shall be in accordance with Section 02551.03.

B. Fire Hydrant Installation

1. Fire hydrants shall be installed and restrained in accordance with the Standard Details, at the locations shown, and to elevations directed by the Engineer. Hydrants shall be set within a gravel or crushed stone drainage well extending the full width of the trench.
2. Hydrant leads shall be laid level on a firm foundation to insure that the hydrant is set plumb. Backfill around the hydrant shall be compacted so as to obtain a density of a least 95% of maximum when measured in accordance with AASHTO T180, Method D.
3. Where hydrants are to be relocated, the Contractor shall ascertain whether or not the hydrant valve has been restrained before removing the hydrant to be relocated. The lead shall be capped and blocked so that service can be restored to the parent main pending the removal or plugging of the mainline tee.
4. The outside of all fire hydrants above finished grade shall be painted with a minimum of two coats of Charles County Hydrant Yellow, Mix #A-Y36/L-12 paint as manufactured by Duron, or County approved equal. Hydrant bonnets shall be painted with a minimum of two coats of Scotch Lite reflective yellow, Mix #7211/OP, manufactured by 3M, or County approved equal.

02554.04 METHOD OF MEASUREMENT

- A. RESERVED FOR FUTURE USE

02554.05 BASIS OF PAYMENT

A. General

RESERVED FOR FUTURE USE

B. Fire Hydrants

RESERVED FOR FUTURE USE

C. Fire Hydrant Lead Pipes

RESERVED FOR FUTURE USE

SECTION 02555

PRODUCTION WELLS

02555.01 GENERAL

A. Description

Water production wells will be double cased, lap or fully double cased construction, drilled by the mud rotary or reverse rotary drilling methods, unless otherwise specified in the Contract Documents. A drawing depicting the general design of a water production well can be found at the end of this section.

B. Related Work Included Elsewhere

1. Protection of the Environment; Section 01500.

C. Quality Assurance

1. Materials
 - a. Materials supplied for Water Production Wells shall be as outlined in the American Water Works Association Standard for Water Wells (AWWA A100-84), unless otherwise specified in the Contract Documents. The County Engineer will inspect all materials before installation to ensure compliance with Contract Documents.
2. Construction Standards
 - a. Construction of water wells will be done in accordance with AWWA A-100-84, Code of Maryland, Title 26 Department of the Environment; Subtitle 04 Water Supply, Sewage Disposal and Solid Waste, Chapter 04 Well Construction (COMAR 26.04.04) and as specified herein.
3. Testing
 - a. Testing for well plumbness and alignment, production and efficiency and water quality will be in accordance with AWWA A-100-84 and the United States Department of Environmental Protection Safe Drinking Water Act as it pertains to ground water and as specified herein.
4. Acceptance Standards
 - a. In order to assure that the County is provided with a sand, silt, bacteria, turbidity, free and efficient well, certain minimum standards must be met before the well is accepted. The County Engineer may waive the acceptance level of a certain standard if it is determined by the County

Engineer that the failure to meet the standard was beyond the Contractor's control and/or will not materially effect the long-term use of the completed well.

- b. Minimum acceptance standards are:
- 1) Sand and silt content: Each Group A water sample shall have a concentration of less than 3.0 mg/l total suspended and settleable solids one minute after water from the screen area arrives at the sampling point or any time thereafter.
 - 2) Turbidity: Each Group A water sample shall have a turbidity concentration of 5.0 NTU or less one minute after water from the screen arrives at the sampling point or any time thereafter.
 - 3) Chlorine Residual: The chlorine residual shall be less than 0.1 mg/l when determined in the field at the time of all bacteriological sampling.
 - 4) Bacteria: Each Group B sample shall have no indication of residual chlorine and will have less than 1 coliform organisms per 100 ml of sample using the membrane filter method of analysis. In addition, the total plate count analysis of each Group B sample shall indicate that bacteria organisms are equal to or less than two (2) organisms per 100 ml of sample.
 - 5) Efficiency: The production well will be at least 80% efficient, unless otherwise specified in Contract Documents, as determined by the County Engineer, based on the results of the long-term pumping test. The values of aquifer transmissivity (T) and storativity (S) used in the determination of well efficiency will be based solely on data gathered during the construction and long-term pump testing of the production well.

The efficiency of the well will be determined by comparing the actual drawdown in the production well with the theoretical drawdown in the production well, calculated at a distance equal to the inside diameter of the well screen. The theoretical drawdown in the production well will be calculated using the Theis nonequilibrium well equation. Partial penetration of the aquifer will not be considered in the determination of efficiency if 75% or more of the aquifer is screened.

In the event that an observation well, which is screened over the same interval as the production well, is available during the long-term pumping test, values of aquifer transmissivity and storativity will be determined from the drawdown data collected in the observation well. In the absence of an observation well, aquifer transmissivity will be calculated using the Time/Time' vs. Residual Drawdown method, and aquifer storativity will be estimated from published data, previous reports or other appropriate sources as determined by the County Engineer.

The comparison of theoretical and actual drawdown will be made at a specific time, determined by Owner's Representative, during which long-term pumping test data was used to calculate aquifer parameters. The percentage well efficiency will be calculated as:

$$(\text{Theoretical Drawdown}/\text{Actual Drawdown}) \times 100$$

- c. Should the Contractor fail to meet any one of the acceptance standards the Contractor may be allowed to continue development or test pumping and/or disinfection of the well for a reasonable period of time, in order to meet the standards, as agreed upon by the County Engineer. The well shall then be re-tested, if necessary. Any additional development, test pumping, disinfection or other work will be at the Contractor's expense and will include the County's costs for consulting and inspection services. Should the Contractor not be able to meet any of the required acceptance standards, the County Engineer may reject that portion of the Work and require the Contractor to vacate the site.
5. Permits
 - a. The Contractor shall arrange for, obtain and pay for all permits, inspections and tests necessary for the proper execution of the work, in accordance with all Federal, State and Local rules, regulations and codes. In particular, the Contractor will complete, submit and pay for the well drilling permit which must be obtained from the Charles County Health Department, Division of Environmental Health. Copies of the well permit and all other permits shall be presented to the County Engineer upon receipt and shall be posted, if required, at the project site. A copy of all completion reports sent to the State of Maryland or other agencies will be submitted to the County Engineer along with the drillers own reports and logs.
 6. Warranty
 - a. The Contractor warrants that all workmanship, material and equipment furnished and installed by the Contractor shall be free of defects or failure for a period of one (1) year after the well is placed into regular service and, should such defects appear, the Contractor shall repair such defects at no cost to the Owner.

D. Submittals

1. Driller's Report: During construction, the Contractor shall maintain, on a daily basis, a report of all activities pertaining to the work. The report will be submitted on report forms provided by the County, a sample copy of this form is shown can be found at the end of these specifications. The Daily Report form will be completed and signed by the Contractor's Licensed Driller in charge of the work and submitted to the County Engineer during the County Engineer's inspection of the work.
2. Driller's Logs: During installation of the pilot hole, the Contractor shall prepare and keep a complete a log of the formations penetrated on a Driller's Log form

provided by the County, a sample copy of this form can be found at the end of these specifications. The Driller's Log form shall be prepared and signed by a driller licensed in the State of Maryland. The Driller's Log will be submitted to the County Engineer upon the completion of the pilot hole.

3. Sieve Analysis: Copies of the sieve analysis from selected pilot hole formation samples shall be submitted upon receipt to the County Engineer. Sieve analysis shall be performed by the well screen manufacturer or person experienced and qualified to perform such analysis.
4. Shop Drawings: In addition to the shop drawings required in the "General Provisions", the Contractor shall, prior to the installation of any casing or well screen, submit to the County Engineer a detailed cross section of the well. The drawing shall indicate exact lengths, diameters, materials, slot sizes, depths and other dimensions of the casing, screens, adapters, blank sections, riser pipe, gravel pack, grout and all other appurtenances pertaining to the well.
5. Manuals and Manufacturer's Literature: After construction, the Contractor shall furnish copies of any documents, certifications, manuals, specifications and manufacturer's literature pertaining to the materials and/or equipment installed permanently or temporarily during the Work. Six copies of these documents shall be submitted to the County Engineer.
6. Gravel Pack: The Contractor, prior to delivery, shall submit to the County Engineer samples of the gravel pack proposed for use along with a current sieve analysis of the gravel showing gradation and uniformity coefficient.
7. Well Profile: Upon completion of testing, the Contractor shall submit a well profile to the County Engineer. A sample copy of this form can be found at the end of these specifications.
8. Water Samples and Analysis
 - a. Sampling Coordination: The Contractor will notify the County Engineer 48 hours prior to collecting samples. The State of Maryland Department of the Environment will also be notified (in the time frame required by them) so that they may collect water samples as required by their regulations.
 - b. Analysis Required: The Contractor shall furnish the following water analysis of samples collected at various times during testing. The analysis are grouped according to the times of collection and where the analysis will be performed. The cost of the analysis is to be included in the Lump Sum Amount bid.
 - 1) Group A: turbidity (NTU) and total suspended and settleable solids.
 - 2) Group B: total coliform (membrane filter), total plate count and chloride residual.

- 3) Group C: pH, eH (redox potential), specific conductance, temperature, M.O. and P alkalinity (CaCO₃), free carbon and turbidity.
 - 4) Group D: chloride, fluoride, total hardness, total iron, nitrate nitrogen, manganese, sodium, total dissolved solids, arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, copper, zinc, carbonate, bicarbonate, magnesium, sulfate, calcium, color, foaming agents, odor, Langlier Index, silica, potassium, volatile organic compounds EPA Method 524.2, radio nuclides, EPA Method 60014-75-008 including beta, radium 226, radium 228, radon EPA Method 600-75-012 and all other compounds regulated under Phase I, Phase II and Phase V amendments to the Safe Drinking Water Act.
 - 5) Group E: Required samples provided to the Maryland Department of the Environment.
- c. All sample analysis shall be performed by a certified laboratory having all state and/or federal approvals necessary under the Safe Drinking Water Act for the constituents requested. A laboratory representative shall collect the samples in Groups C and D. The Contractor can collect the samples in Groups A and B using bottles and sample preservation techniques provided by the laboratory. The chlorine residual will be determined by the Contractor in the field at the time the Group B samples are collected using an approved field test kit capable of detecting chlorine residual to .1 mg/l. The analysis of samples in Group C shall be performed in the field by a laboratory representative as soon as possible after they are collected.

02555.02 MATERIALS

A. Materials furnished by the County

- 1. The County will not furnish any materials for Production Well Construction.
- 2. The Contractor may obtain water from the County's system, if available for well construction purposes. Water used will be invoiced at prevailing rates. The Contractor shall contact the County's Department of Fiscal Services, Meter Section for requirements. A backflow prevention device must be placed in accordance with the Standard Details prior to drawing County water.

B. Contractor's Option

The Contractor may furnish any of the specified materials or "equal" materials as approved by the County Engineer unless otherwise noted in the "SPECIAL PROVISIONS".

C. Detailed Materials Requirements

- 1. Surface or starter well casings shall be made of non-galvanized steel and shall be of such a size to allow proper grouting of the outer well casing.

2. Outer well casings shall be new. They shall be made of non-galvanized steel and conform to ASTM Class A53 and AWWA A-100-84 specifications. Casings shall be I.P.S. "STANDARD" schedule wall thickness, unless otherwise specified. All casings shall be plain end and machine beveled for welded connections. Casing diameters are outlined in the Contract Documents. All steel pipe used in well construction shall bear mill markings that will readily identify it.
3. Stainless steel well screens shall be new, continuous slot, wire wound screen (Johnson Filtration Systems, Inc. or equivalent). The screen shall be constructed of wound wire, reinforced by longitudinal bars. The bars shall have a cross-section that will form an opening between each adjacent coil of wire that is shaped in manner as to increase in size inward. The wire shall be firmly attached to the bars which in turn, will be attached to a coupling adapter. The well screen will be constructed of Type 304 stainless steel. The screen dimensions will be outlined in the contract documents. Water entrance velocities for the screen selected will not exceed 0.1 feet per second at the anticipated pumping rate stated in the Contract Documents.
4. Blank sections between screen sections, cellar or sump sections, transition sections from the top of the well screen to the relief screen and inner casing shall be the same diameter and constructed of the same material as the well screen, unless specified otherwise. Solid pipe blank sections and inner casings will be I.P.S. "STANDARD" schedule wall thickness, unless otherwise specified. Tight Wound well screen may be used in place of solid pipe blank sections between well screens.
5. Relief screens shall have the same slot size and be the same diameter and constructed of the same material as the well screen, unless specified otherwise.
6. The end plate for the well screen, cellar or sump section shall be constructed of the same material as the well screen, unless specified otherwise.
7. Well screens, blank sections, inner casing, relief screens, cellar or sump sections and end plates will be connected with Type 304 stainless steel welding rings or shall be plain end machine beveled for welded connections.
8. Centralizers shall be made of steel half moon sections or 304 stainless steel expandable straps.
9. The filter gravel for the gravel pack should consist of material that is composed of sound, durable, subrounded to rounded rock and mineral fragments. The particles shall consist mainly of quartz and/or quartzite and shall contain no limestone or other calcareous material, such as shell fragments and no organic material, such as wood fragments or lignite. The gravel shall be purchased from a commercial supplier who shall certify that the material is suitable for use in potable water wells. Gravel shall be as supplied by the Jessie Morie Co. or approval equal. The gravel pack material shall be graded and sized to be suitable and compatible with the formations present and screen slot size(s) selected. The gravel shall meet industry standards for sorting and size distribution within the stated range. The uniformity co-efficient of the gravel pack materials shall be no greater than 1.7. The gravel pack material shall be delivered to the site in bags or in bulk. If delivered in bulk, it shall be placed on 6

mil. plastic sheeting at a raised location so as not to be subjected to any type of surface run-off. The material shall be kept clean and dry at all times.

10. Neat cement for grouting production well outer casings shall consist of a mixture of Portland Cement ASTM C-150 Type 2 or Type 3, and water, with not more than 6 gallons of clean water per bag of cement used. If premixed cement is purchased, a certificate of composition must be presented to the County Engineer upon delivery. The use of special cement or other admixtures (ASTM C-494) to reduce permeability, increase fluidity and/or control time of set and the composition of the resultants slurry, must be submitted to the County Engineer for review and approval prior to use.

02555.03 EXECUTION**A. PREPARATION**

1. The Contractor shall notify the County Engineer one week prior to all Work and tests called for in these specifications, including the start of drilling and the start of pumping tests. The Maryland Department of Natural Resources and the Department of the Environment shall be notified within the time frames required by these Department's, prior to the long-term test, so the test may be observed and samples collected.
2. The Contractor shall be responsible for all necessary measures to prevent erosion or sedimentation on or adjacent to the site as a result of the Work. Settling basins and/or traps shall be employed as necessary during the drilling operation in order to re-use the fluids required for drilling. The Contractor will not be permitted to bury cuttings on-site. All supernatant fluid is to be removed from the mud pits and trenches and the pits are filled with clean earth and allowed to stabilize. Obtaining suitable off-site disposal of all discarded fluids and other materials will be the responsibility of the Contractor. The requirements of this section in no way relieves the Contractor from complying with any site specific soil and sediment erosion control plans for this work.
3. All measurements indicated in these specifications are from the surface of the ground at the site. Actual depths used during the proposed Work will be dependent upon information obtained from drilling. All measurements made in the field during drilling and testing shall be made from a well defined referenced point. A complete description of this reference point (or sampling point) shall be included on all submittals provided by the Contractor. The elevation of each reference point used shall be specified with respect to ground surface and some permanent benchmark established by the County Engineer at each site. All depth measurements shall be within + or - .1 feet except water-level measurements which shall be + or - .01 feet.
4. The Contractor shall employ only competent workmen for the execution of this Work and all such Work shall be performed under the direct supervision of an experienced and licensed Master Well Driller (State of Maryland) satisfactory to the County Engineer.

B. DRILLING FLUID

1. Only potable water from a source approved by the County Engineer will be used during construction. If available, arrangements may be made with the County to secure a source of water from the Department's distribution system as described in Section 02555.02.A.2.
2. Material used by the Contractor to prepare the drilling fluid shall be composed of fresh, non-polluted water and sodium bentonite type drilling clay commercially processed to meet or surpass the viscosity specifications in the American Petroleum Institute "Std. 13-A for Drilling Fluid Materials". Any other drilling fluid additive to be used must, prior to use, be approved by the County Engineer. Their use will comply with recognized industry standards and practices and they will be applied and used as described by the manufacturers. It is expressly understood that toxic and/or dangerous substances will not be added to the drilling fluid.
3. The drilling fluids program shall be agreed to by the Contractor and the County Engineer prior to use. Selection and use of the drilling fluid materials shall be a part of this agreement. The Contractor shall be responsible for maintaining the quality of the drilling fluid to assure:
 - a. The protection of water bearing and potential water bearing formations exposed in the borehole.
 - b. That good representative samples of the formation materials are obtained.
 - c. That water, free of bacteria and other contaminants, as later described in these specifications, is obtained from the finished well.

C. PILOT HOLE DRILLING

1. A pilot hole, for formation sampling and geophysical logging shall be drilled from ground surface to a depth and diameter as outlined in the Contract Documents. The sediments penetrated shall be sampled as specified herein.
2. During the drilling of the pilot hole, sediment samples shall be collected as follows:
 - a. The Contractor shall obtain return flow samples by removing from the circulating drilling fluid a representative sample of the formation by either collecting the samples in a cutting sample box, sediment shaker, a baffle in a ditch, or catching them in a bucket and allowing the sample to settle out. Care shall be taken so that the sampling device is not contaminated with sediments other than those being obtained from the sampling interval. Provision shall be made to determine the exact depth of the formation from which the cuttings are derived by exact measurements of the drill pipe and calculation of up hole velocity of the drilling fluid. When collecting samples, at a prescribed collection interval, drilling shall be suspended and the drilling fluid circulated for the time required to bring the sample to the collection point. The method of collecting samples and the time interval required for bringing the samples to the collection point must be approved by the County Engineer prior to the start of drilling.

- b. Formation samples shall be collected at 10-foot and 5-foot intervals as outlines in the Contract Documents. Samples shall also be collected at any pronounced change of formation. Special care shall be used when collecting samples from the aquifer.
- c. Two representative samples shall be obtained for each sampling interval of 10 feet. At least three representative samples shall be obtained when the sampling interval is 5 feet.
- d. Immediately after retrieval, formation samples shall be placed in suitable containers, securely closed to avoid spillage and contamination and clearly labeled in a permanent manner with at least the following information:
 - 1. Location of the well.
 - 2. Name or number of the well.
 - 3. Depth interval represented by the sample.
 - 4. Date taken.
- e. One set of samples collected from the aquifer and selected in conjunction with the County Engineer shall be delivered to Johnson Filtration, Systems Inc. (or equivalent soils testing facility) so that sieve analysis can be performed for tentative selection of the well screen. The remaining samples shall be safely stored until they are accepted by the County Engineer and the State of Maryland Geological Survey.

D. GEOPHYSICAL LOGGING

- 1. At the conclusion of pilot hole drilling the County Engineer will conduct geophysical logs in the pilot hole.
- 2. Caliper logs will be performed, by the County Engineer, after the pilot hole has been reamed to accept the outer casing and after the formation area has been reamed to accept the well screen.
- 3. The Contractor will give the County Engineer 24 hours Notice, prior to having the pilot hole or reamed hole ready for logging.
- 4. The Contractor will be given a copy of all logs performed, by the County Engineer, immediately after the logging is completed.
- 5. If a geophysical logging tool is lost and not retrievable, the Contractor may drill out or drill by the tool, if in the County Engineers opinion doing so will not materially effect the well. If the Contractor is unable to drill out or by pass the tool, the Contractor will abandon the hole, in accordance with the regulations of the Maryland Department of the Environment and will redrill to the designated diameter and depth.

6. If the geophysical tool is lost due to Contractor negligence or problems with the drilled hole, the Contractor will reimburse the County Engineer for the lost equipment and will perform the necessary abandonment and redrilling at no additional cost to the County. Any cost for additional geophysical logging required due to the Contractor's negligence or problems with the drilled hole will be borne by the Contractor.

E. WELL CONSTRUCTION

1. The outer casing will extend to the top of the water bearing aquifer.
2. All surface (starter) casing and outer casings will be grouted in place with a minimum of 2 inches of grout surrounding the casings.
3. Well screens will be gravel packed in place with a minimum of 4 inches of gravel surrounding the well screen.
4. If the Contractor decides to install a surface (starter) casing, it shall in no way infringe on grouting the outer casing or obtaining a proper seal. Any surface (starter) casing used will be left in place and shall be included in the Lump Sum bid price.
5. Screen slot size, configuration, setting and gravel pack size will be selected by the Contractor and approved by the County Engineer based on all previous work and the intent of these specifications. The Contractor shall check the driller's logs, geophysical logs, and sieve analysis of the samples obtained from pilot hole to reach a decision concerning screen slot size, gravel size and screen placement.
6. The well casings and screen sections will be installed in the pre-drilled hole in such a manner as to be suitably aligned and plumb. They shall be grouted or gravel packed in place as required. Centralizers shall be installed between the inner and outer casing at three equal distance points between the bottom of the outer casing and the top of the inner casing. Installation of the casing, grouting same and installation of the well screen and gravel packing same, will be done on an around the clock basis. Well casings and screen connections shall be welded in accordance with the current standardized procedures of the American Welding Society.
7. The outer casing shall be set round, plumb, and true to alignment. The tests for alignment in the outer casing shall be made following the setting in the casing and before the installation of grout. Alignment shall be tested by lowering into the well a section of 6-inch diameter or larger pipe which is 40 feet long with guides on each end and in the middle. The outer diameter of the guides shall not be more than 1/2-inch smaller than the diameter of that part of the casing being tested. The guides shall be a minimum of 1.0 feet long.
8. Immediately after the Contractor has performed the alignment test, the test for plumbness shall be made by the County Engineer with a plummet suspended from a tripod on the drill rig. The plummet will be approximately 1/2-inch smaller in diameter of the well casing being tested. The Contractor shall assist the County Engineer in making the test for plumbness.

9. Should the alignment dummy or the plummet fail to move freely throughout the entire length of the casing being tested, or should the well depth vary from the vertical in excess of 2/3-rds of the smallest inside diameter of that part of the well being tested, per 100 foot in depth, the plumbness and/or alignment of the well shall be corrected by the Contractor at the Contractor's own expense. Should the Contractor fail to correct the faulty plumbness and/or alignment, the County Engineer may refuse to accept the well and require that another well be constructed at another location on the property. The inside and outside of the existing casing or borehole, if the casing is removed, would then be abandoned (as specified) at the Contractor's expense. The County Engineer may waive the requirements for plumbness and alignment if, in the County Engineer's judgment, the defect is due to circumstances beyond the Contractor's control and/or the utility of the completed well will not be materially affected. Any retesting or alignment or plumbness will be done at the Contractor's expense including the County's cost for consulting and inspection services.
10. The annular space between the drilled hole and the outer casing shall be sealed by pressure grouting from the bottom of the casing to ground level. This may be accomplished by the use of a Tremie pipe set to the bottom of the casing or by some other method recommended by the Contractor and approved by the County Engineer.
11. After the inner casing and well screen are securely positioned in the well, the Contractor shall furnish and install a gravel pack between the screen and borehole. The Contractor shall be responsible for ensuring that the gravel pack material is adequately disinfected during installation. The gravel pack shall be placed adjacent to the screen using the Tremie Pipe Method, so that the entire open space between the screen and borehole is uniformly filled with gravel. The borehole shall be continually flushed with clean water to remove drilling mud and natural clays, prior to and during gravel packing.

F. WELL DEVELOPMENT

1. A method of development will be used which will result in the removal of fine material in the vicinity of the well screen, increase the material porosity of the undisturbed formation and remove the mud cake and drilling fluid from the borehole. This is to be accomplished with a method of development which will cause a reversal of flow through small sections of the well screen combined with pumping to remove color and fine materials. Initial development shall be accomplished by either air surging with a tight fitting double block surge and educator pipe, with the surge blocks spaced no more than 5 feet apart or by a combination of high velocity jetting and pumping. The maximum rate of development, utilizing either of these methods, shall be 5 feet of well screen per hour. After initial development other methods of development such as, but not limited to, mechanical surging, air pumping or high capacity pumping with a test pump may be utilized. Development, by either of the above described initial methods, must be done prior to installing a test pump.
2. Chemical and other development aids to improve the efficiency of the well and to assist in its development may be permitted subject to the prior approval of the County Engineer. Concentrated discharges from the well shall be disposed of in a safe and acceptable manner in accordance with these specifications and any applicable State or Federal regulations.

3. The Contractor, as part of this Work may conduct tests periodically to check the progress of development and well efficiency. All of these tests shall be included in the Lump Sum bid amount.
4. Development shall be sufficient to provide a minimum acceptable efficiency for the well as defined under the Acceptance Standards outlined in the "Quality Assurance" section of these specifications. After the pumping tests, the Contractor may continue to develop the well for a period of 30 days in order to attain minimum requirements. All additional development and re-testing necessary to meet the Acceptance Standards will be at the Contractor's expense, including the County's cost for consulting and inspection services.

G. TEST PUMPING

1. When the Contractor, at the Contractor's own determination, feels the Contractor can meet the acceptance standards, the well shall be pumped to determine aquifer characteristics, well efficiency and to collect representative water samples from the aquifer. Testing shall be accomplished as follows:
 - a. General Equipment: The Contractor shall furnish all labor, tools, pumps, piping, electric cable, controls, generators, flow measuring devices and other appurtenances necessary for the performance of test pumping as required by these specifications. The Contractor shall furnish the necessary pumping equipment and measuring instruments to pump at stepped rates, as outlined in the Contract Documents with throttling control satisfactory to the County Engineer, measure the discharge rate in a manner satisfactory to the County Engineer and to carry the pumped water to an acceptable discharge point as directed. The pump intake shall be set at the depth outlined in the Contract Documents or at some other depth, recommended by the Contractor and approved by the County Engineer, determined as a result of tests conducted during development. The pumping unit shall be complete with ample power source, controls, and appurtenances and shall be capable of operation without interruption for a period of at least 24 hours. The test pump shall be fitted with a foot valve or check valve, at the pump head, to prevent the flow of water back into the well during recovery. Oil lubricated test pumps may not be used for well development or testing.
 - b. Water-Level Measurement: A clearly marked convenient reference point shall be established at the top of a water-level measuring pipe which the Contractor shall insert in the pumped well along with the test pump.
 - c. Flow Measurement: The discharge from the well shall be measured using a pipe, piezometer tube and orifice plate. The configuration of this equipment shall meet industry standards and also be acceptable to the County Engineer.
 - d. Sampling Port: The Contractor shall furnish a 1-1/4-inch IPT opening in the discharge pipe before the beginning of the orifice pipe for the installation of sampling equipment to be furnished by the County Engineer. The discharge pipe shall be free of valves, changes in pipe

diameter or other obstructions for a distance of 24-inch will be free of any external obstruction except for the discharge pipe itself.

- e. Step Test: An initial pumping test will be conducted in the well at stepped rates as outlined in the technical specifications and in the field by the County Engineer. The total test period for the step test will be 6 continuous hours. The Contractor shall operate the pump and vary the discharge as directed by the County Engineer.
- f. Long-Term Test: After a rest period of at least 12 hours, during which the well has recovered from the step test, a constant rate test shall be conducted by pumping the well at a rate as outlined in the Contract Documents or as directed by the County Engineer, for a period of 24 hours, followed by a recovery test period of 24 hours. The pumping rate for the 24 hour test will be selected so as to provide maximum drawdown in the well using the following criteria:
 - 1. Results of the step test.
 - 2. Capacity of test pump as stated in the Contract Documents.
 - 3. The available capacity at a pumping level as stated in the Contract Documents.

The long-term test shall be composed of two parts, a drawdown portion and a recovery portion. The Contractor must wait 24 hours after shut down to remove the Contractor's pump and to allow for the collection of water-level data.

- g. Water-level measurements shall be obtained in the pumped well and a test/observation well (if available) by the Contractor as directed by the County Engineer. Measurements of water level during the pumping and recovery period shall be made as follows:

0- 20	.....	every minute
0- 40	.....	every 2 minutes
40- 100	.....	every 5 minutes
100- 240	.....	every 10 minutes
240-1450	.....	every 25 minutes

During testing, the County Engineer may designate a frequency which varies somewhat from the above. The Contractor shall provide at least one (1) person to measure and record pumping test data at times when the County Engineer is not present at the site.

- h. During the initial step test and during the constant rate 24-hour test, failure of pump operation during the first 150 minutes of pumping or for more than 15 minutes at anytime, thereafter, shall require suspension of the test until the water level in the pumped well has recovered to its original level. The time of the restart of the test shall be approved by the County Engineer and shall take into account staff scheduling and water sampling. The County Engineer shall be the sole judge as to whether

recovery has been completed and when the pump shall be restarted. During the test, the pumping rate shall not fluctuate more than one (1) percent of the designated rate or the test may be terminated. Any retesting will be done at the Contractor's expense including the County's cost for consulting and inspection services.

- i. Water discharged during the pumping test shall be conducted to a point of acceptable disposal as approved by the County Engineer. The Contractor shall be responsible for correcting, at the Contractor's own expense, any damage caused by the discharged water.

H. WATER SAMPLING ARRANGEMENTS

1. Water samples for quality analysis, as required under the "Submittals Section" of these specifications, will be collected during the long-term pumping test as follows:
 - a. Group A: Two samples; the first one minute after water from the screen area arrives at the sampling point. The time lapse from the start of pumping to taking this sample will be determined by the capacity being pumped and the upward velocity of the water in the well casing and the pump discharge column. The second sample will be taken during the last 30 minutes of the pumping test.
 - b. Group B: Three samples; one during each of the last 3 hours of the pumping test.
 - c. Group C: One sample during the last 30 minutes of the pumping test with the analysis conducted in the field at the time of sampling.
 - d. Group D: One sample during the last 30 minutes of the pumping test for transport to the laboratory for analysis.
 - e. Group E: Assist in the collection of necessary samples by the State of Maryland during the last hour of the test.

I. WELL DISINFECTION

1. The Contractor shall furnish all labor, materials, transportation, tools supplies, plant equipment and appurtenances necessary for the satisfactory disinfection of the well. Disinfection of the well shall be as provided by "AWWA Standard for Deep Wells A-100-84". The chlorine solution used for disinfecting the well shall be of such volume and strength and shall be so applied that a concentration of at least 100 PPM is established in the well in accordance with the directions of, and to the satisfaction of, the County Engineer and shall remain in the well for a period of at least 12 hours. After the required disinfection period and with the approval of the County Engineer, the chlorinated water from the well shall be pumped to a discharge location as approved by the County Engineer. The well shall also be disinfected at various times during the Work as deemed necessary by the Contractor.

2. Upon removal of the test pumping equipment, a sufficient amount of disinfectant shall again be added to the well prior to capping to provide a chlorine residual in the well of 50 ppm.
3. All chlorinated waters pumped from the well must meet with the conditions set forth in the Maryland Department of Environment Water Supply Bulletin entitled "Discharge of Chlorinated Waters", July 31, 1989, before being released to any drainage system.

J. TV SURVEY OF THE COMPLETED PRODUCTION WELL

1. At the conclusion of testing and prior to capping the production well, the County Engineer will conduct a TV survey of the well to confirm construction details and dimensions. The Contractor will assist the County Engineer in conducting the survey.
2. The Contractor is responsible to take whatever steps are necessary to clear the water in the well so a clear TV picture is obtainable.

K. WELL CAPPING

1. Whenever the well is left unattended, a temporary well cap or drill tool with suitable plates will be placed on the well to prevent entry. Upon completion, the well shall be capped to prevent unauthorized entry.

L. WELL ABANDONMENT

1. If the Contractor deems it necessary, or if instructed by the County Engineer that the drilled hole or a partially constructed well must be abandoned, it shall be done in accordance with the regulations of the State of Maryland, Department of Environment.

M. WATER DESIGN CRITERIA

The criteria contained in the table on the following page shall be used for all water systems with elevated or ground storage.

02555.04 METHOD OF MEASUREMENT

A. Outer Casing

RESERVED FOR FUTURE USE

B. Well Screens and Blank Section

RESERVED FOR FUTURE USE

02555.05 BASIS OF PAYMENT

A. General

RESERVED FOR FUTURE USE

**DAILY DRILLING REPORT
Unconsolidated Formations**

Well Name or Number: _____ Date: _____

Location: _____

Contractor: _____

Contractor's Job No.: _____

County Contract No.: _____

Time on-site

Start: _____ am pm

Stop: _____ am pm

Description of On-site Work	Crew Hours	Equipment on-site:			
		from	to	dia.	remarks
Mobilization - set up					
Geophysical logging					
Plumbness - Align. testing					
Pilot hole drilling					
Reaming					
Setting casing					
Grouting					
Drilling into aquifer					
Setting screen					
Setting riser pipe					
Gravel packing					
Developing		Type drilling fluid:			
Setting/removing test pump		Cement amount:			
Test pumping		Screen slot size:			
Collecting recovery data		Gravel size:			
Breakdown - cleaning up		Water clarity:			
Other:		Pumping rate(s):			
		SWL: PWL:			
Name of Driller:		State License No.:			
Names of Helpers:					
Remarks:					
Driller's signature:			Inspector's signature:		

