

SECTION 32 84 00

PLANTING IRRIGATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Contractor is responsible for providing a programmable, fully automatic system with full and complete coverage within the areas indicated on the Drawings. Furnish all labor, materials, supplies, equipment, tools, and transportation, and perform all operations in connection with and reasonably incidental to the complete installation of the fully functional irrigation system, and warranty as shown on the Drawings, the installation details, and as specified. Other items of Work specifically included are:
1. Procurement of all applicable licenses, permits, and payment of required fees.
 2. Coordination of Utility Locates ("Call Before You Dig").
 3. Maintenance period services.
 4. Sleeving for irrigation pipes and wires as indicated, and/or beneath all hardscape surfaces.

1.2 DEFINITIONS

- A. Lateral Piping: Piping located downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.
- B. Mainline Piping: Located downstream from point of connection to water distribution piping to, and including, control valves. Piping is under system pressure.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- D. Hardscape: Site roads, walks, walls, or any other surface improvements for which removal for excavation to perform maintenance or replacement of the irrigation system pipes or wires will require disturbance of other than landscape materials.

1.3 RELATED WORK

- A. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.
- B. Submittals: SECTION 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Concrete: Section 03 30 00, CAST-IN-PLACE CONCRETE.
- D. Excavation, Backfill: Section 31 20 00, EARTH MOVING.

E. Section 32 90 00, PLANTING.

1.4 QUALITY ASSURANCE

A. Irrigation Contractor:

1. Irrigation Contractor must have demonstrated, using persons directly employed by the Contractor, experience with the construction of at least five (5) irrigation systems having large diameter gasketed pipe (6-inch and larger), centralized control systems with hardwired or radio communication, electrically operated remote control valves, and large radius rotary sprinklers (minimum 1-inch inlet with swing joint).
2. 5 jobs performed by the contractor should have been on irrigation systems with 1000 GPM or greater supply.
3. Irrigation Contractor must be licensed in the State of California, C-27 license.
4. Irrigation Contractor must be a Certified Irrigation Contractor with the Irrigation Association.

B. Equipment Manufacturer:

1. Manufacturer regularly and presently manufactures the item submitted as one of their principal products.
2. There is a permanent service organization, maintained or trained by the manufacturer, which will render satisfactory service within 24 hours of receipt of notification that service is requested.
3. Installer, or supplier of a service, has technical qualifications, experience, and trained personnel and facilities to perform the specified Work.

C. Products Criteria:

1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units are products of one manufacturer.
2. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
 - a. All components of an assembled unit need not be products of the same manufacturer but component parts which are alike are the product of a single manufacturer.
 - b. Components are compatible with each other and with the total assembly for the intended service.
3. Nameplates: Nameplate bearing manufacturer's name or identification trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

D. System Requirements:

1. Full (head to head plus 10%) and complete coverage of the irrigated areas is required. Contractor shall, at no additional cost to the Government, make necessary adjustments to head locations as required to achieve full coverage of irrigated areas.
2. Layout Work as closely as possible to Drawings. Drawings are diagrammatic to the extent that swing joints, offsets and all fittings are not

- shown. Diagrammatic also refers to the location of the pipelines and valves, which may have been adjusted for clarity of the Drawings. Lines are to be common trenched wherever possible.
3. Locations of remote control valves is schematic. Remote control valves shall be grouped wherever possible and aligned at a set dimension back of curb along roads. Remote control valves shall be located individually or in groups of two, to minimize tripping hazards. Where the exact location for the valves has not been set, or there are any conflicts, the location shall be coordinated with the COR before installation.
 4. Irrigation lines and control wire shall run at boundaries of graves, thru designated utility lanes or beside roadways so that any gravesite may be opened in the future without disruption of the irrigation system.
 5. Irrigation lines, control wires and power wires shall be run in trenches as indicated on the Drawings or as typical for industry standards, if not indicated.
 6. Connect new system to existing mains.
 7. Unless noted otherwise, all irrigation lines, power wires and control wires shall be run in sleeves or conduit where installed beneath any site hardscape materials.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a qualified testing agency, and marked for intended location and application.
- F. Completely program central controller and satellite controllers according to approved master irrigation schedule.
- G. Follow manufacturer's instructions for installation.
- H. Manufacturer of Control Systems to certify Control System is complete, including all related components, and totally operational. Submit certificate to COR.

1.5 SUBMITTALS

- A. Make submittals and provide number of copies per Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Unless otherwise noted, provide four (4) copies of irrigation information in a 3-ring binder with table of contents and index sheet. Provide sections that are indexed and labeled for valves, sprinklers, pipe and fittings, wire and wire connectors, ID tags, shop drawings, "DO NOT DRINK" sign and all other irrigation equipment shown or described on the Drawings and within these Specifications. Highlight items being supplied on the catalog cut sheets. Submittal package must be complete prior to being reviewed by the COR. Incomplete submittals will be returned without review. Sequentially number each page of the submittal for ease in referencing during submittal review. Pages within a letter or number identified tab section may be numbered sequentially as long as the process is consistent and provide unique page identification for each page of the submittal.
- B. Materials List: Include all materials and products that are part of the irrigation system including, but not limited to: pipe, fittings, valves, mainline components,

water filtration components, electrical components and control system components. Quantities of materials need not be included.

- C. Manufacturers' Data: Submit manufacturers' catalog cuts and Specifications for equipment to be included in the project Work. For rotary sprinklers include Center for Irrigation Technology Space Pro Single Leg Profile showing the Distribution Uniformity and Scheduling Coefficient for the nozzles being used at the specified spacing.
- D. Joint Restraint Calculations: Submit calculations for all joint restraints used based on manufacturer's recommendations.
- E. Testing: Submit a proof of testing report following completion of each test listed in Part 1 of this Section. Unless otherwise noted, include name of test, date of test, name of the individual completing the test, name of the company completing the test and a summary of the test results. If system fails test, document any and all retests until system passes test.
- F. Maintenance and Operation Instructions: Submit information listed in Part 3 of this Section.
- G. Record Drawings: Submit information listed in Parts 1 and 3 of this Section.
- H. Name and address of a permanent service organization maintained or trained by the manufacturers that will as a result of determined warranty Work, or after warranty period following execution of a service Contract for this facility, render satisfactory service within 24 hours of receipt of notification that service is requested.
- I. Reproducible "As Built" drawings. Submit information indicating the "As Built" conditions for the irrigation system to the COR. As-builts shall be made using GPS survey grade equipment and shall be new and independent from design plans and shall be provided in both printed/laminated form as well as dwg file.
 - 1. After electronic "as built" drawings have been approved, the Contractor shall utilize them to prepare an overall irrigation system drawing to replace the existing one with this expansion area included of a size suitable for display at the location determined appropriate by the Cemetery operations staff proximate to the irrigation central control computer.
- J. Controller Chart:
 - 1. Prepare a map diagram showing location of all valves, lateral lines, and route of the control wires. Identify all valves as to size, station, number and type of irrigation. "As built" Drawings must be submitted and approved before charts are prepared.
 - 2. Provide one controller chart showing the area covered by controller for each automatic controller supplied at the maximum size controller door will allow. Chart shall be a reduced drawing of the actual "as built" system. If controller sequence is not legible when the drawing is reduced to door size, the drawing shall be enlarged to a size that is readable and placed folded, in a sealed plastic container, inside the controller door.

3. Chart shall be a print with a different color used to show area of coverage for each station. Charts must be completed and approved prior to final inspection of the irrigation system.
4. Controller chart shall include all existing stations already on controller.

1.6 SUBSTITUTIONS

- A. Unless otherwise noted, use specified equipment to match existing equipment. COR must approve equipment prior to construction. Changes and associated design costs to accommodate alternative equipment are Contractor's responsibility. "As Built" information shall show the sizes installed.
- B. Pipe sizes referenced in the construction documents are minimum sizes, and may be increased at Contractor's option.

1.7 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and appurtenances unless otherwise indicated.
 1. Irrigation Mainline Piping: 200 psig.
 2. Lateral Piping: 150 psig.

1.8 CODES AND REGULATIONS

- A. Work and materials will be in accordance with the latest edition of the National Electric Code, the Uniform Plumbing Code, and applicable laws and regulations of the governing authorities.
- B. When the Contract documents call for materials or construction of a better quality or larger size than required by the above-mentioned rules and regulations, provide the quality and size required by the Contract documents.
- C. If quantities are provided either in these Specifications or on the Drawings, these quantities are provided for information only. It is the Contractor's responsibility to determine the actual quantities of all material, equipment, and supplies required by the Project and to complete an independent estimate of quantities and wastage.

1.9 AVAILABILITY AND USE OF UTILITY SERVICES

- A. The government shall make NO utilities available to the Contractor from existing outlets and supplies except as follows. Upon completion of the new irrigation system for this Project or completion of portions thereof, the Contractor through the permanent connection of the new irrigation system to the existing fully functional irrigation system, shall be provided water at available flow and pressure, for use by the Contractor, with Contractor provided additional facilities and/or equipment as required to perform the required flushing and testing of the new irrigation system. Once the irrigation system is deemed operable and approved, and prior to the final inspection, the Contractor may use water at no cost through the irrigation system for establishing turf and maintaining plant material. The use of water for new landscape establishment shall be coordinated

with the existing Cemetery irrigation operations so as to not adversely affect their operations or the existing irrigated landscape materials. No other expressed or implied uses of Government-furnished water exist.

- B. The Contractor, at Contractor's expense and in a workmanlike manner satisfactory to the COR, shall install and maintain all necessary temporary connections and distribution lines, and meters required for providing temporary irrigation water. Before final acceptance of the Work by the Government, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated appurtenances.

1.10 TESTING

- A. Notify the COR three days in advance of testing.
- B. Newly installed irrigation pipelines jointed with rubber gaskets or threaded connections shall be subject to pressure and leakage testing after partial completion of backfill. Pipelines jointed with solvent-welded PVC joints will be allowed to cure at least 24 hours before testing.
- C. Subsections of mainline pipe may be tested independently, subject to the review of the COR.
- D. Furnish clean, clear water, pumps, labor, fittings, power and equipment necessary to conduct tests or retests.
- E. Volumetric Leakage Test – Gasketed Mainline Pipe:
 - 1. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
 - 2. Purge all air from the pipeline before test.
 - 3. Provide all necessary pumps, bypass piping, storage tanks, meters, 3 inch test gauge, supply piping, and fittings in order to properly perform testing. Testing pump must provide a continuous 100 psi pressure to the mainline pipe. Where main lines are installed with significant elevation change, perform the test at the mid elevation of the segment being tested. Main lines may be tested in segments where the terrain makes it difficult to maintain the test pressure throughout. The test pressure is the minimum pressure on the line at the highest point of the line segment being tested.
 - 4. Allowable deviation in test pressure is 5 psi during test period. Average pressure during the test shall be 100 psi therefore the pressure shall start at 5 psi above and be re-pressurized when the pressure is 5 psi below the test pressure. Restore test pressure to 100 psi at end of test. Water added to mainline pipe must be measured volumetrically to nearest 0.025 gallons.
 - 5. Subject mainline pipe to the anticipated operating pressure of 100 psi for two hours. The amount of additional water pumped in during the test will not exceed the value in the table, or the calculated value using the formula below, based upon differing number of joints, duration or pressure of the test:

Leakage Allowable (Gallons per (100 Joints) / Hour)

| PIPE SIZE (INCHES) | Test Pressure (PSI) | | | | | | | | |
|-----------------------|---------------------|------|------|------|------|------|------|------|------|
| | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 |
| 2 ½" | 0.26 | 0.28 | 0.30 | 0.32 | 0.34 | 0.35 | 0.37 | 0.39 | 0.40 |
| 3" | 0.31 | 0.34 | 0.36 | 0.38 | 0.41 | 0.43 | 0.44 | 0.46 | 0.48 |
| 4" | 0.42 | 0.45 | 0.48 | 0.51 | 0.54 | 0.57 | 0.59 | 0.62 | 0.64 |
| 6" | 0.63 | 0.68 | 0.73 | 0.77 | 0.81 | 0.85 | 0.89 | 0.92 | 0.96 |
| 8" | 0.84 | 0.90 | 0.97 | 1.03 | 1.08 | 1.13 | 1.18 | 1.23 | 1.28 |
| 10" | 1.05 | 1.13 | 1.21 | 1.28 | 1.35 | 1.42 | 1.48 | 1.54 | 1.60 |
| 12" | 1.26 | 1.36 | 1.45 | 1.54 | 1.62 | 1.70 | 1.78 | 1.85 | 1.92 |

Note: Allowable Leakage calculated using $L = (ND\sqrt{P})/7400$

Where: L = Allowable Leakage (gph)
 N = Number of Joints
 D = Nominal Diameter of Pipe (inches)
 P = Average Test Pressure (psi)

6. The following are the values for a 2 hour duration test at 100 psi for pipe length containing 100 joints.
 - a. 0.82 gallons per 100 joints of 3 inch diameter pipe
 - b. 1.08 gallons per 100 joints of 4 inch diameter pipe
 - c. 1.62 gallons per 100 joints of 6 inch diameter pipe
 - d. 2.16 gallons per 100 joints of 8 inch diameter pipe
 - e. 2.70 gallons per 100 joints of 10 inch diameter pipe
 - f. 3.24 gallons per 100 joints of 12 inch) diameter pipe
 7. Volumetric leakage exceeding the amounts indicated above, adjusted for system test pressure, number of joints and shall be a failure of the test. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat the test until the pipe passes test.
 8. Cement or caulking to seal leaks is prohibited.
 9. Contractor may sub-contract testing to pipeline testing company approved by COR. Provide results to COR.
 10. Test shall be done prior to trenches being backfilled completely.
- F. Hydrostatic Pressure Test – Solvent Weld Lateral Pipe:
1. Subject lateral pipe to a hydrostatic pressure equal to the anticipated operating pressure of 80 psi for 30 minutes.
 2. Cap all sprinkler risers.
 3. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
 4. Leakage will be detected by visual inspection. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat the test until the pipe passes test.
 5. Cement or caulking to seal leaks is prohibited.

6. After lateral passes test and prior to operational test, install sprinklers and backfill and compact all pipe, fittings, joints, or appurtenance.
- G. Operational Test – Remote Control Valves, Lateral Piping and Sprinklers:
1. Activate each remote control valve in sequence from each new satellite controller manually at the controller, automatically from the Central Computer, and via any handheld units through their stand alone communication system. Manual operation on the valves from the bleed valve on the remote control valve is not an acceptable method of activation. The COR will visually observe operation, water application patterns, and leakage.
 2. Replace defective remote control valve, solenoid, wiring, or appurtenance to correct operational deficiencies.
 3. Replace, adjust, add, or move water emission devices to correct operational or coverage deficiencies.
 4. Replace defective pipe, fitting, joint, valve, sprinkler, or appurtenance to correct leakage problems. Cement or caulking to seal leaks is prohibited.
 5. Repeat test(s) until each lateral passes all tests. Repeat tests, replace components, and correct deficiencies at no additional cost to the Owner.
- H. Distribution Uniformity (DU):
1. Perform a DU Test on one zone of burial section rotors and one zone of tree lawn rotors per satellite controller. Verify that DU meets submittal requirements of this Section.
 2. In conjunction with the COR, select the zones of sprinklers that are representative of the area being irrigated by the satellite controller.
 3. Perform a catch can test using procedures recommended by the Irrigation Association.
 4. Where DU test fails adjust zone pressures and/or nozzle sizes to meet required Distribution Uniformity.
 5. Calculate and provide a written documentation of the DU for each zone tested.
 6. An Irrigation Association Certified Landscape Irrigation Auditor must perform the test. Provide written evidence of certification prior to conducting test.
 7. Use all Irrigation Association Certified Landscape Irrigation Auditor forms filled out with all data.
- I. Control System Grounding:
1. Test all new satellite controllers for proper grounding of control system with installed grounding equipment that creates grounding resistance readings of 5 ohms or less, or as acceptable by equipment manufacturer without equipment warranty invalidation. Test results must meet or exceed control system manufacturer's requirements for acceptance, while maintaining equipment warranty.
 2. Replace defective wire, grounding rod or appurtenances. Repeat the test until the manufacturer's requirements are met. Add grounding rods as needed, bond all rods together.
 3. If the test is acceptable, the individual completing the test must document the results of the grounding test on the inside of each satellite controller pedestal door and via a written report submitted to the COR.

Documentation should include satellite name or number, date of test, name or initials of the individual completing the test, and the ohms resistance to ground. The test results should be marked on the inside of each satellite controller pedestal door using a permanent marker.

4. A written report of the test data listing satellite name or number, date of test, name of the individual completing the test, name of the company completing the test and the ohms resistance to the local ground for each satellite must be submitted to the COR.
- J. Irrigation System Acceptance Test (Burn in) Prior to Final Inspection:
1. Upon completion of construction and prior to Final Inspection, an Acceptance Test (Burn in) must be passed.
 2. Coordinate start of Test with COR.
 3. During the Test, the irrigation system must be fully operational from the central control system and stand-alone programs at the individual satellites. The irrigation system must operate with no faults for 14 consecutive days. If at any time during the 14 day test period, a system fault occurs, the source of the fault must be determined and corrected and the 14 day evaluation period will start again. If a system fault occurs, make repairs within 24 hours of notification from COR. Document any faults in the proof of test report listing date of fault, fault, cause of the fault and the corrective action taken.
 4. When the system has operated for 14 days without fault, contact the COR to schedule Final Inspection.
 5. If the system is designed to detect flow and shut down and this condition happens during test, this is considered a success and test continues; if it does not shut down the test starts over
- K. Central Control to Supervisory Control and Data Acquisition (SCADA) System Communication Test:
1. Replace defective wire, wire connections or appurtenances. Repeat the test until the manufacturer's guidelines are met.
 2. Test communication between the irrigation central control computer and the SCADA equipment.
 3. The Irrigation Delivery Software (IDS) shall function in coordination with the SCADA System for the Irrigation Water Supply Source (IWSS) and IDS systems to operate on fully automatic mode for 14 consecutive days.

1.11 WARRANTY AND REPLACEMENT

- A. The purpose of the warranty is to insure that the Government receives irrigation materials of prime quality, installed and maintained in a thorough and careful manner.
1. Warranty irrigation materials, equipment, and Workmanship against defects for a period of one year from Final Acceptance by COR. Fill and repair depressions. Restore landscape, utilities, structures or site features damaged by the settlement of irrigation trenches or excavations. Repair damage to the premises caused by construction or a defective item. Make repairs within 24 hours of notification from COR.

2. Replace damaged items with identical materials and methods per Contract documents or applicable codes. Make replacements at no additional cost to the Contract price.
 3. Warranty applies to originally installed materials and equipment and replacements made during the Warranty period.
- B. All of the following items shall have 10 year manufacturer's warranty:
1. Ductile iron fittings
 2. Gate Valves
 3. Joint Restraints
 4. Angle Valves

1.12 GENERAL CONSTRUCTION REQUIREMENTS

- A. Coordinate construction of irrigation system with COR or Cemetery Staff. Coordinate temporary shut-down of existing system with Cemetery Staff prior to construction. Disturbance to cemetery operations must be minimized. See irrigation plans and installation details and Specifications Sections for required coordination efforts related to the installation of specific irrigation components.
- B. Connections to the existing mainline must be approved by the COR while minimizing the impact on the operation of the existing irrigation system.
- C. Install irrigation mainline and control and power wiring in sleeves under new roads prior to installation of road base, and under all other concrete or asphalt, either existing or new for this project.
- D. Install irrigation components in landscaped areas unless specifically indicated otherwise. Irrigation components in other than landscaped areas shall be in sleeves.
- E. Construction cannot proceed unless staking of irrigation mainline, remote control valve locations, and sprinkler locations are reviewed and accepted by the COR.

1.13 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - A242 Standard Specification for High-Strength Low-Alloy Structural Steel
 - A536 Standard Specification for Ductile Iron Castings
 - B61 Steam or Valve Bronze Castings
 - B62 Composition Bronze or Ounce Metal Castings
 - B88 Standard Specification for Seamless Copper Water Tube
 - D1784 Rigid Poly(Vinyl Chloride)(PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
 - D1785 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, 120

- D1894 Standard Test Method for Static and Kinetic Coefficients of Friction of Plastic Film and Sheet
- D2241 Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)
- D2464 Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- D2466 Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
- D2564 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
- D2855 Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
- D3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
- F477 Elastomeric Seals (Gaskets) for Joining Plastic Pipe

- C. American Water Works Association (AWWA):
 - C110/A21.10 Ductile-Iron and Gray-Iron Fittings, 3-Inch Through 48-Inch for Water
 - C111/A21.11 Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - C115/A21.15 Flanged Ductile Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
 - C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast, for Water
 - C153/A21.53 Ductile-Iron Compact Fittings for Water Service
 - C509 Resilient-Seated Gate Valves for Water Supply Service
 - C600 Installation of Ductile-Iron Water Mains and Their Appurtenances
 - C651 Disinfecting Water Mains

- D. Manufacturers Standardization Society (MSS):
 - SP70 Cast Iron gate Valves, Flanged and Thread Ends

- E. National Electrical Manufacturers Association (NEMA):
 - 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

PART 2 - PRODUCTS

2.1 QUALITY

- A. Use new materials without flaws or defects.

2.2 SUBSTITUTIONS

- A. Unless noted otherwise, use specified equipment. Equipment used will match the equipment installed in the previous phase as noted. COR must approve equipment prior to construction. The Contactor through written request prior to purchase or installation may request substitutions to the approved equals listed herein. Changes and associated design costs to accommodate alternative equipment are Contractor's.

- B. Pipe sizes referenced in the construction documents are minimum sizes, and may be increased at Contractor's option.

2.3 SLEEVING

- A. Provide sleeves beneath all hardscape for irrigation pipe and all wiring. Provide separate sleeves beneath hardscape for wiring.
- B. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting the requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with an integral belled end.
- C. Use C905, DR-18 rated at 235 psi confirming to dimensional and tolerances established by ASTM Standard D2241 for mainline pipe sleeves larger than 12-inch.
- D. Use AWWA C900 PVC pipe, rated at 200 psi for mainline pipe sleeves up to 12-inch.
- E. Sleeve sizes are to be as shown on the Drawings or twice the nominal diameter of pipe if not shown. The wiring bundle area may not exceed more than 40% of the sleeve cross sectional area, per NEC recommendations.
- F. Restrained Casing Spacers:
 - 1. Use restrained casing spacers on gasketed mainline pipe contained in a sleeve. Provide restrained casing spacers for gasketed joints that occur within sleeve and as necessary along pipe length.
 - 2. Sleeve Size: As shown in the Drawings or manufacturer's details.
 - 3. Use casing spacers manufactured from high strength ductile iron, per ASTM A536, Grade 65-45-12. Use restraining rods manufactured from high strength low alloy material meeting the requirements of ASTM A242 and ANSI/AWWA C111/A21.11. Use runners manufactured from ultra-high molecular weight polymer with a tensile impact of 600-1200 ft-lbs./in. and a coefficient of friction of 0.14-0.17 per ASTM D1894.

2.4 PIPE AND FITTINGS

- A. Irrigation Mains:
 - 1. Provide one of the following materials:
 - a. Polyvinyl Chloride (PVC) Pressure Pipe, AWWA C900, PVC 1120, minimum Working pressure 150 psi. Pipe shall conform to outside diameters of AWWA C151 cast iron pressure pipe to accommodate cast iron fittings.
 - b. Polyvinyl Chloride (PVC) Pressure Pipe I.P.S. SDR 17 (250 PSI) ring-tite pipe, conforming to dimensions and tolerances established by ASTM Standard D2241.
 - 2. Use rubber-gasketed pipe equipped with factory installed reinforced gaskets for mainline pipe. Gasketed pipe joints must conform to the "Laboratory Qualifying Tests" section of ASTM D3139. Gasket material

must conform to ASTM F477. Use push-on rubber-gasketed ductile iron fittings according to paragraph 2.4.E.

3. Mainline pipe within sleeves: Provide restrained casing spacers for gasketed joints that occur within sleeve and as necessary along pipe length.

Lateral Pipe and Fittings:

4. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting the requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with an integral belled end suitable for solvent welding.
5. Use SCH 40 conforming to dimensions and tolerances established by ASTM Standard D2241. Use PVC pipe rated at higher pressures than Class 200 in the case of small nominal diameters not manufactured in Class 200.
6. Use solvent weld pipe for lateral pipe. Use Schedule 80, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784 for PVC pipe. Use primer approved by pipe manufacturer. Solvent cement to conform to ASTM Standard D2564, of type approved by pipe manufacturer.

B. Threaded Pipe:

1. Polyvinyl Chloride, ASTM D1785, PVC 1120, Schedule 80, for threaded connections, risers and swing joints.

C. Pipe Above Grade and in Concrete Structures:

1. AWWA C115, flanged joints and fittings working pressure 150 psi.

D. Fittings:

1. Irrigation Mains:
 - a. Ductile Iron and PVC Pipe: All mainline 3" and larger shall have ductile iron fittings with mechanical joint restraints. Use mechanical joints conforming to ANSI A 21.10 (AWWA C110) and ANSI A21.11 (AWWA C111) or flanged fittings conforming to ANSI/AWWA C110 and ANSI B16.1 125 pounds. All fittings shall be installed with retainer glands designed for the pipe material, and shall be manufactured with twist off screws that shear off at the proper force to anchor the retainer gland to the pipe at the pressure rating for the pipe, or at the test pressure for the pipe, whichever is higher, without causing damage to the pipe.
2. Irrigation Laterals:
 - a. PVC, schedule 40, solvent welded socket type, ASTM D1785-15.
3. Threaded Pipe:
 - a. PVC, schedule 80, ASTM D2464.
4. Unitized Swing Joints:
 - a. Shall be a standard complete assembly by a manufacture, with elastomeric seals that allow 360 degree rotation, and are designed for minimum 200 psig working pressure.

- E. Jointing Materials:
1. Irrigation Mains: Rubber gaskets, AWWA C111. Use pipe lube with gaskets.
 - a. All mainline 3" and larger shall have ductile iron fittings with mechanical joint restraints or self-restrained joints.
 - b. All flanged fittings shall be installed with retainer glands.
 2. Irrigation Laterals, 2.5" and below: Use Schedule 80, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784 for PVC pipe. Use primer approved by pipe manufacturer. Solvent cement to conform to ASTM Standard D2564, of type approved by pipe manufacturer.
 3. Threaded pipes: Use non-hardening, non-toxic pipe joint sealant formulated for use on water-carrying pipes on all threaded connections. Do not use Teflon tape or Teflon sealant.
- F. Accessories:
1. Pipe Gasket Lubricant.
 2. Pipe Bedding Material per Section 31 20 00, EARTH MOVING.
 3. Pipe Initial Backfill: Sand per Section 31 20 00, EARTH MOVING.
 4. Electrical Conduit: Schedule 40 PVC UL listed

2.5 RESTRAINTS

- A. Joint Restraint Harness:
1. Use a joint restraint harness as presented in the Drawings and/or as indicated in manufacturer's printed directions wherever there are changes in mainline direction and joints are not positively restrained by flanged fittings, threaded fittings, and/or retainer glands. Thrust blocks may not be used in lieu of joint restraint harnesses.
 2. Use cast in place concrete thrust blocking in addition to mechanical joint restraints on pipe sizes 6" and larger following wrapping of joints with 6 mil polyethylene sheet and taping closed on to pipe material minimum 6 inches clear from joint.
 3. Use a joint restraint harness with all ductile iron fittings 6 inch and larger, transition fittings between metal and PVC pipe, where weak trench banks do not allow the use of thrust blocks, or where extra support is required to retain a fitting or joint.
 4. Use a joint restraint harness, joint restraints with clamps and straps, or self-restrained joints on all mainline gate valves and ductile iron fittings 3-inches and larger.
 5. Use epoxy-coated ductile iron joint restraints conforming to ASTM A-536, Grade 65-45-12 & AWWA C153. Use with Type 316 stainless steel bolts and nuts.
 6. Submit Joint Restraint Calculations per 1.5.D.
- B. Thrust Blocks:
1. Use thrust blocks for fittings on pipe greater than or equal to 6 inch diameter in conjunction with mechanically restrained joints. Use of mechanical restraints does not eliminate the need for installation of thrust blocks as specified. Thrust blocks must be used with mechanical restraints on all pipe sizes 6 inch and larger.

2. Use 3,000 psi concrete.
3. Use 6-mil plastic sheet.
4. Use No. 4 rebar wrapped or painted with asphalt tar based mastic coating.

2.6 MAINLINE COMPONENTS

- A. Valves (Except remote control valves):
1. General valve installation shall be as presented in the installation details. Unless specifically noted otherwise, valves for existing facilities shall match the existing, of the same type. All valves shall meet or exceed any specified parameters identified herein, or the parameters for the existing valves being matched, whichever provided the higher quality product.
 - a. Underground Shut-Off Valves: Provide one or more of the following based upon project specific conditions. Use type in paragraph 1) unless there are special circumstances that require the other types:
 - 1) Gate valves 2 inches and larger: Iron body, bronze mounted, double disc with parallel or inclined seats, non-rising stem turning clockwise to close, 150 psi minimum working pressure. AWWA C509.
 - b. Check Valves: Swing.
 - 1) Smaller than 4 inches: Bronze body and bonnet, ASTM B61 or B62, 125 pound WSP.
 - 2) 4 inches and larger: Iron body, bronze trim, vertical or horizontal installation, flange connection, 200 pound WOG.
 - c. Pressure Reducing Valve: Cast steel body with renewable seats, with stainless steel trim. Flow passages and all parts designed to withstand high velocity applications, flange connected. Unless otherwise noted, pressure reducing valves shall be adjustable to the desired pressure, within the selected range of operation specified.
 - d. Air-Vacuum Relief Valve: Cast Iron body with epoxy coating, polypropylene float, glass fiber reinforced nylon kinetic float, Buna-N seals and O-rings, stainless steel nuts and bolts, pressure range 2 psi to 230 psi. Use a continuous acting combination air and vacuum and air release valve.
 - e. Quick Coupling Valve Assembly:
 - 1) As presented in the installation details.
 - 2) Brass construction, 1-inch nominal size, operating pressure 5-125 psi with locking rubber or vinyl cover. For new installations use high quality brass, bronze or stainless steel manufacturer's equipment for similar golf course or lite commercial applications.
 - 3) Swing Joint: Use pre-manufactured triple swing joint. Quality of manufactured product shall meet or exceed that of products manufactured by Spears, Lasko, or approved equal.
 - 4) Quick Coupler Anchor: Use pre-manufactured bolt on anchor.

- 5) Valve Box: Use plastic (ABS) 10-inch round valve box with purple lid. Product quality shall meet or exceed that of Brooks Products or approved equal.
 - 6) Filter Fabric: Use a spunbond polyester 3.5 oz per square yard landscape fabric.
- B. Flower Water Station Spigot Connection Assembly:
1. As presented in the installation details.
 2. Flower Watering Station Spigot: As specified in Section 32 30 00, SITE FURNISHINGS.
 3. Curb Stop Valve: Brass body, 300 psi minimum working pressure. ASTM B62, female threaded connections, with stop and waste feature.
 4. Inline pressure regulator, 40 psi maximum, 1-inch maximum inlet and outlet.
 5. Copper Pipe: Use Type "M" soft tubing conforming to ASTM B88. Use wrought copper or cast bronze fittings, soldered, flared mechanical, or threaded joint per installation details. Use a 95-percent tin and 5-percent antimony solder.
 6. Valve Box: Use a concrete curb valve box with cast iron lid sized 8" ID x 12". Valve box must be capable of being face anchored in concrete.
 7. The final approved configuration, including the mounting method shall be as approved during the Submittal process.
- C. Valve Box:
1. Gate and Butterfly Valve:
 - a. Valve boxes in pavement shall be precast concrete with compressive strength of the concrete in excess of 4,000 psi. In turf and planter areas valve boxes shall be HDPE structural foam Type A, Class III. Box shall be minimum 19 inches long by 14 inches deep with key-lockable hinged lid.
 - b. Box shall be of such length to be adapted to depth of cover required over pipe at valve location. Mark box cover to differentiate between lawn irrigation system and domestic water supply system and set flush with finished grade.
 - c. Operations:
 - 1) Underground: furnish valves with 2 inch nut for T-Handle socket wrench operation.
 - 2) Above ground and in pits: MSS SP70, with handwheels.
 - 3) All butterfly valves 6 inches and above shall have enclosed gear drive operators.
 - 4) Ends of valves shall accommodate the type of pipe installed. Valves on buried irrigation mains shall have Mechanical Joint ends with retainer glands.
 2. Remote Control Valves:
 - a. When in pavement, valve boxes shall be precast concrete with compressive strength of the concrete in excess of 4,000 psi. In planter areas, valve boxes shall be HDPE structural foam Type A, Class III. Box shall be minimum 19 inches long by 14 inches deep with key-lockable hinged lid.
 - 1) After installation hot brand into lid of valve boxes 3 inch high, 3/16" deep labels designating the controller and

circuit numbers with permanent white epoxy paint.
Numbers shall be placed at center of valve cover and shall
face nearest main road or service road.

2.7 SPRINKLER IRRIGATION COMPONENTS

A. Remote Control Valve Assembly:

1. Remote control valve:
 - a. As presented in the installation details. Installation shall result in the control valve being installed underground and operated by a 24-volt AC electric solenoid. Valves shall be of heavy duty construction and shall have manual shut-off and flow control adjustment and provide for manual operation. Install valves with unions on each side to allow for easy removal. Valves shall have a minimum of 150 psi working pressure. Higher working pressure valves shall be provided for systems that operate with working pressures above 140 psi. Install assembly over gravel sump as presented in the installation details.
 - b. Valves shall be of all brass or plastic construction furnished as straight or angle pattern type, or valve body shall be cast-iron with brass bonnet, trim and renewable seat and have two inlet tappings (furnished with one plugged) to allow installation as either a straight or angle pattern valve.
 - c. Valves shall be diaphragm type designed to operate in water containing sand and debris and shall have a self-cleaning type contamination filter to filter all water leading to the solenoid actuator and the diaphragm chamber. Valve shall incorporate a nonadjustable type opening and closing speed control for protection against surge pressures, or valves shall operate by means of a slow acting direct drive without ports, screens or diaphragms.
 - d. Valves shall contain pressure regulators.
 - e. Valves shall be completely serviceable from the top without removing valve body from the system. Valves to operate at no more than 7 psi pressure loss at manufacturers maximum recommended flow rate.
2. Ball Valve: Use bronze or brass ball valves, two-piece, full-port, with stainless steel handle.
3. PVC Union: Use a Schedule 80 threaded union with O-ring seal. Acceptable manufacturer is Spears or approved equal.
4. Filter Fabric: Use a spunbond polyester 3.5 oz. per square yard landscape fabric.
5. Wire connectors: Use 3M DBY or DBR.
6. Use standard Christy I.D. tags with hot-stamped black letters on a yellow background.

B. Pop-Up Gear-Driven Rotary Sprinkler Assembly:

1. Full Circle Sprinklers: To be a dual or tri-nozzle combination type with positive drive by means of a gear assembly. Sprinkler head to rotate uniformly and to be driven by means of a train of gears. Sprinklers to be equipped with an integral anti-drain valve to be self-closing at pressures

- of 10 feet of head or less. Gears and pinions shall be assembled on stainless steel spindles in a water-lubricated sandproof gear case. An inlet screen shall prevent debris from entering the sprinkler and shall be removable with the internal assembly. Sprinklers outer case shall be constructed of corrosion resistant, impact resistant, heavy-duty ABS.
2. Part circle sprinklers to be variable arc type as required with same type drive used for full circle heads.
 3. Turf Rotors to be equipped with flow shut-off device built into the head.
- C. Low Voltage Control Valve Wire:
1. Wire: Solid copper wire, Underwriters Laboratories Inc. approved for direct burial in ground. Size of wire shall be in accordance with manufacturer's recommendations, but in no case less than No. 14.
 2. Splicing Materials: Epoxy waterproof sealing packet.
 3. Low voltage controller cable: Multi-strand cable, Underwriters Laboratories Inc. approved for direct burial in ground. Size and type of wire shall be in accordance with manufacturer's recommendations.
- D. Warning Tape:
1. Standard, 4-Mil polyethylene 3 inch wide tape, detectable type, purple with black letters, and imprinted with "CAUTION BURIED IRRIGATION WATER LINE BELOW".
- E. Tracer Wires:
1. No. 14, Green, Type TW plastic-coated copper tracer wire shall be installed with non-metallic irrigation main lines.

PART 3 - EXECUTION

3.1 INSPECTIONS AND REVIEWS

- A. Site Inspections:
1. The Contractor shall verify construction site conditions and note irregularities affecting Work of this section. Report irregularities to the COR prior to beginning Work.
- B. Utility Locates ("Call Before You Dig"):
1. Arrange for and coordinate with local authorities, or contract with a local private utility locating service, and with cemetery maintenance personnel for the location of all underground utilities.
 2. Repair any underground utilities damaged during construction. Make repairs at no additional cost to the Government.
- C. Irrigation System Layout Review: Irrigation system layout review will occur after the staking has been completed. Notify the COR one week in advance of review. The COR will identify and approve modifications during this review.

3.2 LAYOUT OF WORK

- A. Stake locations of alley and sprinklers in existing burial sections using a licensed surveyor. Use alleys as identified on the Drawings.
- B. Stake out the irrigation system. Items staked include: irrigation mainline pipe, thrust blocks, isolation gate valve assemblies, air/vacuum relief valve assemblies, quick coupling valves, remote control valves, lateral piping, and sprinklers.
- C. If staked irrigation components conflict with utilities or other components or site features, coordinate rerouting of components with COR.

3.3 EXCAVATION, TRENCHING AND BACKFILLING

- A. Excavate to permit the pipes to be laid at the intended elevations and to permit Workspace for installing connections and fittings.
- B. Do not lay pipe on unstable material, in wet trench or when, in the opinion of the COR, trench or weather conditions are unsuitable for the Work.
- C. Pressure tests shall not be made for a period of 36 hours following the completion of pouring of thrust blocks.
- D. Allow a minimum of 3 inches between parallel pipes in the same trench.
- E. Hold pipe securely in place while joint is being made.
- F. Do not work over, or walk on, pipe in trenches until covered by layers of earth well tamped in place to a depth of 12 inches over pipe.
- G. Install supply line and conduits on pipe bedding. Full length of each section of pipe shall rest upon the pipe bed with recesses excavated to accommodate bells or joints. Do not lay pipe on wood blocking. Refer to Section 31 20 00, EARTH MOVING for pipe bedding requirements.
- H. Install sprinkler lines to avoid electric ducts, storm and sanitary sewer lines, water and gas mains, all of which have right of way.
- I. Clean interior of pipe of foreign matter before installation. Keep pipe clean during laying operations by means of plugs or other methods. When Work is not in progress, securely close open ends of pipe and fittings to prevent water, earth, or other substances from entering.
- J. Minimum cover:
 - 1. 36 inches over irrigation mainline pipe in landscaped areas and to bottom of asphalt road (distance from top of pipe to finish grade in unpaved areas and concrete paved areas or from top of pipe to top of aggregate base for asphalt paved areas).
 - 2. 18 inches over irrigation lateral pipe to sprinklers (distance from top of pipe to finish grade).

3. 18 inches over control wire when not in common trench with mainline or lateral piping (distance from top of control wire to finish grade).
 4. 18 inches vertical separation between lateral and mainline pipe installed in a common trench.
 5. 3 inches minimum horizontal separation between pipes and wiring in a common trench.
 6. Install sleeves at depth to maintain specified depth of pipe or wire routed through sleeve.
 7. Tops of remote control valves shall never be less than 3 inches below lid of valve box.
- K. Install and maintain safety fencing around all unattended excavation. Place safety signs adjacent to construction area roadway to the satisfaction of the COR.
- L. All excavations must be backfilled by the end of each workday. Do not leave any open trenches overnight, on weekends, or on holidays.
- M. If trenching operation restricts access to a burial section, provide plywood and safety fencing across open trench to allow access to burial section. Provide access to the satisfaction of the COR.
- N. Excavated material is generally satisfactory for backfill. Backfill will be free from rubbish, vegetable matter, frozen materials, and stones larger than 2 inches in maximum dimension. Remove material not suitable for backfill. Backfill placed next to pipe will be free of sharp objects that may damage the pipe.
- O. Enclose pipe and wiring beneath roadways, walks, curbs, etc. in sleeves. Backfill sleeves in the following manner:
1. Backfill trench using excavated material in 6 inch to 8 inch layers. Minimum compaction of backfill for sleeves shall be a minimum 95% ASTM D1557. Backfill to bottom of road base under roads or to finish grade under walks and curbs.
 2. Tape a bare copper tracer wire to top of pipe sleeves terminating at No. 4 rebar stake driven into ground at location of sleeve ends.
- P. Backfill mainline pipe, lateral pipe and wiring in turf areas in the following manner:
1. Backfill the trench by depositing the backfill material equally on both sides of the pipe or wire in 6 inch layers and compacting to the density of surrounding soil.
- Q. Dress backfilled areas to original grade. Remove excess backfill to on-site location as directed by the COR.
- R. Where utilities conflict with irrigation trenching and pipe Work, contact the COR for trench depth adjustments.
- S. Existing sidewalks and curbs shall not be cut during trenching and installation of pipe. Install pipe under sidewalks and curbs by jacking, auger boring, or by

tunneling. Repair or replace any concrete that cracks, due to settling, during the warranty period.

- T. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury. At completion of all Work thoroughly clean fixtures, exposed materials and equipment.
- U. Warning tape shall be continuously placed above sprinkler system water mains at a depth of 12 inches below grade.
- V. Survey monuments:
 - 1. Protect markers during construction.
 - 2. If a survey marker is disturbed during construction, the Contractor is responsible for replacing the marker. The Contractor must hire a licensed surveyor to resurvey the location of the marker and replace it in the proper location at no additional cost to the Government.

3.4 SLEEVING AND BORING

- A. Furnish and install where pipe and control wires pass under walks, paving, walls, and other similar areas.
- B. Install sleeving at a depth that permits the encased pipe or wiring to remain at the specified burial depth.
- C. Extend sleeve ends a minimum of 12 inches beyond the edge of the paved surface. Cover pipe ends and mark edge of pavement with a chisel or saw.
- D. Verify that sleeve sizing is adequate prior to installation. Sleeving to be twice line size or greater to accommodate retrieval for repair of wiring or piping and shall extend 12 inches beyond edges of paving or construction. Cover pipe ends and mark edge of pavement with a chisel or saw. Note that sleeves required for pipe with restrained casing spacers are larger than twice the diameter of the pipe.
- E. Bed sleeves with a minimum of 4 inches of sand backfill above top of pipe.

3.5 ASSEMBLING PIPE AND FITTINGS

- A. General:
 - 1. Keep pipe free from dirt and pipe scale. Cut pipe ends square and debur. Clean pipe ends.
 - 2. Keep ends of assembled pipe capped. Remove caps only when necessary to continue assembly.
 - 3. Trenches may be curved to change direction or avoid obstructions within the limits of the curvature of the pipe. Minimum radius of curvature and offset per 20 foot length of mainline and lateral pipe by pipe size are shown in the following table. All curvature results from the bending of the pipe lengths. No deflection will be allowed at a pipe joint.

| SIZE | RADIUS | OFFSET PER 20' LENGTH |
|------|--------|-----------------------|
| 1 ½" | 25' | 7'-8" |
| 2" | 25' | 7'-8" |
| 2 ½" | 100' | 1'-11" |
| 3" | 100' | 1'-11" |
| 4" | 100' | 1'-11" |
| 6" | 150' | 1'-4" |
| 8" | 200' | 1'-0" |
| 10" | 250' | 9" |

B. Mainline Pipe and Fittings:

1. Plastic pipe:

- a. Shall be snaked in trench at least 1 foot per 100 feet to allow for thermal construction and expansion and to reduce strain on connections.
- b. Joints
 - 1) Solvent Welded Socket Type: ASTM D2855.
 - 2) Threaded Type: Apply liquid teflon thread lubricant of teflon thread type. After joint is made hand tight (hard), a strap wrench should be used to make up to two additional full turns.
 - 3) Elastomeric Gasket: ASTM F477.
 - a) Immediately before joining two lengths of PVC pipe, the inside of the bell or coupling, the outside of the spigot and the elastomeric gasket shall be thoroughly cleaned to remove all foreign material.
 - b) Lubrication of the joint and rubber gasket shall be done in accordance with the pipe manufacturer's Specifications.
 - c) Care shall be taken that only the correct elastomeric gasket, compatible with the annular groove of the bell, is used. Insertion of the elastomeric gasket in the annular groove of the bell or coupling shall be in accordance with the manufacturer's recommendations. Pipe that is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint. Bevel ends of push-on PVC pipe per manufacturer's printed instructions prior to inserting pipe into ductile iron push-on fittings.
 - d) The spigot and bell or coupling shall be aligned and pushed until the reference line on the spigot is flush with the end of the bell or coupling. Pushing shall be done in a smooth, steady motion.

2. Ductile iron pipe:

- a. Installation: AWWA C600.
- b. Joints:

- 1) Mechanical: AWWA C111. Provide sufficient quantities of bolts, nuts, glands and gaskets for each socket opening on pipe and fittings.
 - 2) Push on: Apply thin film of lubricant to gasket and place in proper position in contour of bell. Insert beveled end of joining pipe and make contact with gasket. Force beveled end of pipe to bottom of bell without displacing gasket. Do not caulk. Use only lubricant furnished by manufacturer of pipe.
 - 3) Flanges: AWWA C115. Install only in concrete pits. Make watertight and set not less than 6 inches from walls or floor.
- C. Lateral Pipe and Fittings:
1. PVC Solvent Weld Pipe:
 - a. Use primer and solvent cement. Join pipe in manner recommended by manufacturer and in accordance with accepted industry practices.
 - b. Cure for 30 minutes before handling and 24 hours before pressurizing or installing with vibratory plow.
 - c. Snake pipe from side to side within trench.
 - d. In irrigation isles, coordinate with the location of the monuments to avoid conflicts.
 2. Fittings: The use of cross type fittings is not permitted.
- D. Specialized Pipe and Fittings:
1. Mechanical joint connections: Install fittings, fasteners and gaskets in manner recommended by manufacturer and in accordance with accepted industry practices.
 2. PVC Threaded Connections:
 - a. Use only factory-formed threads. Field-cut threads are not permitted.
 - b. Apply thread sealant in manner recommended by component, pipe and sealant manufacturers and in accordance with accepted industry practices.
 - c. Use plastic components with male threads and metal components with female threads where connection is plastic-to-metal.
- E. Joint Restraint Harness:
1. Install harness in the manner recommended by the manufacturer and in accordance with accepted industry practices.
 2. Use restrained casing spacers for gasketed pipe routed through sleeving. Install harness in the manner recommended by the manufacturer and in accordance with accepted industry practices. Install self-restraining casing spacers at all gasketed pipe bell joints and every 10-feet along the gasketed mainline pipe installed through sleeving. Provide correct number and type of restraints per manufacturer's requirements
- F. Thrust Blocks:
1. Use cast-in-place concrete bearing against undisturbed soil, in conjunction with mechanical restraints.

2. Size, orientation and placement will be as shown on the installation details.
3. Wrap fitting with plastic to protect bolts, joint, and fitting from concrete.
4. Install rebar with mastic coating as shown on the installation details..

3.6 INSTALLATION OF MAINLINE COMPONENTS

A. Setting of valves:

1. No valves shall be set under roads, pavement or walks.
2. Clean interior of valves of foreign matter before installation.
3. Where pressure control valves are installed adjacent to remote control valve, they shall be housed in the same valve box.
4. Set valve box cover flush with finished grade.
5. Install as indicated in the installation details, per manufacturer's instructions.
6. Install where indicated on the irrigation plans.
7. Brand or cast "GV" in 2 inch high by 3/16 inch deep letters on valve box lid.

B. Air/Vacuum Relief Valve Assembly:

1. As presented in the installation details, per manufacturer's instructions.
2. Install where indicated in the irrigation plans at high points of mainline pipe.
3. Brand "AV" in 2 inch high by 3/16 inch deep letters on valve box lid.

C. Quick Coupling Valve Assembly:

1. As presented in the installation details, per manufacturer's instructions.
2. Install where indicated in the irrigation plans.
3. Brand "QC" in 2 inch high by 3/16 inch deep letters on valve box lid.

D. Flower Watering Station Hydrant Connection Assembly:

1. As presented in the installation details, per manufacturer's instructions.
2. Sequence of construction:
 - a. Coordinate exact location with COR.
 - b. Components are to be installed before concrete pad. Coordinate installation with concrete Contractor.
3. Location:
 - a. Stations will be installed at locations indicated on Drawings, centered between adjacent sprinkler locations.
 - b. Route adjacent piping around stations. No mainline or lateral pipe is to be installed under Flower Watering Stations.
4. Paint "FW" in 2 inch high by 3/16 inch deep letters on valve box lid.

3.7 INSTALLATION OF SPRINKLER IRRIGATION COMPONENTS AND QUICK COUPLERS

A. Remote Control Valve Assembly:

1. Mainline Flushing:
 - a. Thoroughly flush mainline before installation of Remote Control Valve Assemblies.

- b. Identify remote control valve service tee(s) to be used for mainline flushing. Plug service tees not being used for flushing.
 - c. Connect 2 inch pipe to flushing service tee(s). Use pipe to direct water away from trench and into drainage swale, curb section or storm sewer, i.e. to an area that will direct the water away from the Work area. Direct water so that it does not disrupt the cemetery operations.
 - d. Use a volume of water such that the velocity in the largest pipe flushing to this point is 3 feet per second.
 - e. Multiple points may be flushed simultaneously.
 - f. Flush for a minimum of 20 minutes. Continue flushing until the water is clear of any and all debris before stopping the flushing operation.
 - g. Disconnect pipe from service tee(s) and install remote control valve(s).
2. Install per manufacturer's recommendations where indicated on the Drawings.
 3. Adjust valve to regulate the downstream operating pressure to 70 psi for rotor sprinklers, 45 psi for rotating stream nozzles and 35 psi for spray sprinklers.
 4. Wire connectors and waterproof sealant will be used to connect control wires to solenoid wires. Install connectors and sealant per the manufacturer's recommendations.
 5. Install only one remote control valve to a valve box. Locate valve box 5 feet from and align square with nearby edges of paved areas.
 6. Attach ID tag with controller station number to control wiring at solenoid.
 7. Brand controller and station number in 2 inch high by 3/16 inch deep letters on valve box lid.
- B. Pop-Up Gear-Driven Rotary Sprinkler Assembly:
1. Thoroughly flush lateral pipe before installing sprinkler assembly. Water must be clear of any debris before flushing operation stops.
 2. Install per the installation details at locations shown on the Drawings.
 3. Locate rotary sprinklers 3 inches from adjacent edges of paved areas, walls or fences.
 4. Install sprinklers perpendicular to the finish grade.
 5. Install swing joint with the appropriate angle between the lateral pipe and the lay length nipple per the installation details.
 6. Supply appropriate nozzle or adjust arc of coverage of each sprinkler for best performance.
 7. Adjust the radius of throw of each sprinkler for best performance.
 8. Install 2 foot square piece of sod around all rotary sprinklers in areas to be seeded.
- C. Sprinkler Heads and Quick Couplers:
1. Shall be placed on temporary nipples extending at least 3 inches above finished grade. After turf is established, remove temporary nipples, ensuring that no dirt or foreign matter enters outlet, and install sprinkler heads and quick couplers at ground surface as detailed.

2. Place part circle rotary sprinkler heads no more than 6 inches from edge, of and flush with top of adjacent walks, header boards, curbs, and mowing aprons, or paved areas at time of installation.
 3. Install all shrub sprays, sprinklers and quick couplers on swing joints as detailed on plans.
 4. Set shrub heads 8 inches above grade and 1 foot from edge of curb or pavement. Stake heads prior to backfilling trenches. Stakes to be parallel to riser.
 5. Install sprinklers and quick coupling valves on a swing joint assembly.
- D. Tree Bubblers
1. Thoroughly flush lateral pipe before installing tree bubbler assembly. Water must be clear of any debris before flushing operation stops.
 2. Install per the installation details at locations shown on the Drawings.
 3. Install swing joint with the appropriate angle between the lateral pipe and the lay length nipple per the installation details.
 4. Install top of bubbler tube/drain grate flush with top of grade.

3.8 INSTALLATION OF CONTROL SYSTEM COMPONENTS

- A. Control Units:
1. Install control units at location(s) shown in the Drawings.
 2. Install electrical connections per control system manufacturer's recommendations and is shown in the Drawings.
 3. Lightning protection: Drive grounding rod(s) into soil its full length. Furnish and install grounding plate(s) as indicated or as required to create the grounding connection with the field tested resistance value equal to or lower that the specified values identified in this specification. Connect #6 AWG copper grounding wire to rod and plate using CADWELD style connections. Brand "GR" in 2 inch high by 3/16 inch deep letters on valve box lid.
 4. Attach wire markers to the ends of control wires inside the controller unit housing. Label wires with the identification number (see Drawings) of the remote control valve to which the control wire is connected.
 5. Connect control wire to the corresponding control unit terminal.
 6. Install permanent receiver for hand held radio if not factory installed.
 7. Install rain sensor and complete electrical connections to per control unit manufacturer's recommendations.
- B. Power Wire:
1. Route power wire as directed on plans. Install with a minimum number of field splices. If a power wire must be spliced, make splice with recommended connector, installed per manufacturer's recommendations. Locate all splices in a separate 12 inch standard valve box. Coil 2 feet of wire in valve box. Brand "WS" in 2 inch high by 3/16 inch deep letters on valve box lid.
 2. All power wire shall be laid in trenches. The use of a vibratory plow is not permitted.
 3. Green wire shall be used as the common ground wire from power source to all satellites. White shall be the common (neutral) wire. All wiring is to be NEC Code compliant.

4. Carefully backfill around power wire to avoid damage to wire insulation or wire connectors.
 5. Unless noted on plans, install wire parallel with and below mainline pipe. Install wire a minimum 2 inches below top of PVC mainline pipe.
 6. Encase wire not installed with PVC mainline pipe in electrical conduit with a continuous run of warning tape placed in the backfill, 8-10 inches below the ground surface, directly over the wiring.
 7. Surface mount wire installed above grade in a professional manner with routing approved by the COR.
 8. Connect wire to power source.
- C. Control Wire:
1. Bundle control wires where two or more are in the same trench. Bundle with pipe wrapping tape spaced at 10 foot intervals.
 2. Control wiring may be chiseled into the soil utilizing a vibratory plow device specifically manufactured for pipe pulling and wire installation. Appropriate chisel must be used so that wire is fed into a chute on the chisel, and wire is not subject to pulling tension. Minimum burial depth must equal minimum cover previously listed.
 3. Provide a 24 inch excess length of wire in an 8 inch diameter loop at each 90 degree change of direction, at both ends of sleeves, and at 100 foot intervals along continuous runs of wiring. Do not tie wiring loop. Coil 24 inch length of wire within each remote control valve box.
 4. Install common ground wire and one control wire for each remote control valve. Multiple valves on a single control wire are not permitted.
 5. Install spare control and common wires as directed on plans.
 6. If a control wire must be spliced, make splice with wire connectors and waterproof sealant, installed per the manufacturer's instructions. Locate splice in turf areas using a valve box that contains an irrigation valve assembly, or in a separate valve box. Use same procedure for connection to valves as for in-line splices. If a separate valve box is used for wire splices, brand "WS" in 2 inch high by 3/16 inch deep letters on valve box lid.
 7. Unless noted on plans, install wire parallel with and below mainline pipe.
 8. Protect wire not installed with PVC mainline pipe with a continuous run of warning tape placed in the backfill 6 inches above the wiring.
 9. Cap all exposed wire ends with wire nuts.
 10. Wiring from master controllers to satellites and stub cuts for future extension shall be located in trench with new mains or in separate trench at back of curb, unless cross-country route is shown. Locate in trench with mains when possible on cross-country routes.
 11. Wiring bundles located with piping shall be set with top of the bundle below top of the pipe. No two wires in any bundle shall be of the same color. Wires shall be bundled, and tied or taped at 15 foot intervals. A numbered tag shall be provided at each end of a wire, i.e., at valve, at field located controllers and at master controller. The number at each end of wire to be the same.
 12. Splicing shall be held to a minimum. A pullbox shall be provided at each splice. No splices will be allowed between field located controllers and remote control valves.

13. Provide 12 inch expansion loops in wiring at each wire connection or change in wire direction. Provide 24 inch loop at remote control valves.
 14. Power wiring for the operation of irrigation system shall not be run in same conduit as control wiring.
 15. Provide minimum 4 spare and 1 spare common wire to ends of each run of mainline pipe; yellow color jacket; stubbing out in wire splice box. Loop spare and common control wires into each remote control valve box along the wire runs.
- D. Instrumentation:
1. Install per manufacturer's recommendations at location indicated on Drawings.
 2. Provide electrical connections between central control system hardware and weather station under direction and observation of central control system manufacturer's personnel.
- E. Communication Cable:
1. Run empty electrical conduit from controller to project limits and stub out conduit into empty 10 inch round valve box labeled "W-S".

3.9 TRACER WIRE INSTALLATION

- A. Tracer wire shall be installed on bottom of trench, adjacent to vertical pipe projections, carefully installed to avoid stress from backfilling, and shall be continuous throughout length of pipe with spliced joints soldered and covered with insulation type tape.
- B. Tracer wire shall follow main line pipe and branch lines and terminate in yard box with gate valve controlling these main irrigation lines. Provide sufficient length of wire to reach finish grade, bend back end of wire to make a loop and attach a Dymo-Tape type plastic label with designation "Tracer Wire."
- C. Record locations of tracer wires and their terminations on project record documents.

3.10 INSTALLATION OF OTHER COMPONENTS

- A. Tools and Spare Parts:
1. Prior to the Review at completion of construction, provide operating keys, servicing tools, spare parts, and any other items indicated on the Drawings.
- B. Other Materials: Install other materials or equipment shown on the Drawings or installation details that are part of the irrigation system, even though such items may not have been referenced in these Specifications.

3.11 TEST AND FLUSHING

- A. Test irrigation system per procedures listed in Part 1.

- B. Flushing: After testing, flush system per procedures listed in other paragraphs in this Section, beginning with larger mains and continuing through smaller mains in sequence. Flush lines before installing sprinkler heads and quick couplers.
- C. Operation Test: Upon completion of the final adjustment of the sprinkler heads to permanent level at ground surface, test each sprinkler section by the pan test and visual test to indicate a uniform distribution within any one sprinkler head area and over the entire area. Operate the entire installation to demonstrate the complete and successful operation of all equipment.

3.12 MAINTENANCE AND OPERATION INSTRUCTIONS

- A. Maintenance and Operating Instructions: Prior to final acceptance, provide verbal instructions to the operating personnel. Provide two additional years of software support for one hour each month. Provide Maintenance and Operating Instructions for the provided irrigation system in the form of manual(s) as follows:
 - 1. Unless otherwise noted, provide irrigation operation and maintenance information in a 3-ring binder with table of contents and index sheet. Provide sections that are indexed and labeled. Provide the following information:
 - 2. Catalog cut sheets for control system, valves, sprinklers, pipe and fittings, wire and wire connectors, ID tags, shop Drawings, and all other irrigation equipment shown or described on the Drawings and Specifications.
 - 3. Manufacturer's Operation and Maintenance manuals.
 - 4. Manufacturer's Technical Service Bulletins.
 - 5. Manufacturer's Warranty Documentation.
 - 6. Software License Information.
 - 7. Recommended routine maintenance inspections for weekly, monthly and annual inspections and recommended actions for the inspections and a recommended method for recording the findings of the inspections.
 - 8. Predictive schedule for component replacement.
 - 9. Listing of technical support contacts.
 - 10. Operation and maintenance submittal package must be complete prior to being reviewed by the COR. Incomplete submittals will be returned without review.
 - 11. Provide video taping of the training for the equipment provided for the project. Training shall be produced on DVD or CD, whichever is compatible with the computer system provided for the central computer, where applicable. Training shall be suitable for refresher by the previously trained employees, or for use by new employees to learn the system equipment. Coordinate the final training presentation with the A/E and COR in outline form prior to creation, to insure that the format and organization of the content is applicable for the facility staff utilization.

3.13 FLUSHING AND DISINFECTING

- A. Flush and disinfect new water lines in accordance with AWWA C651.
- B. Initial flushing shall obtain a minimum velocity in the main of 2.5 feet per second at 40 psi residual pressure in water main. The duration of the flushing shall be adequate to remove all particles from the line.

| Pipe Diameter (in) | Flow (gpm) Required to Produce 2.5 ft/sec (approx.) | Size of Tap. (in.) | | | |
|------------------------|--|--------------------|-----|----|-------|
| | | 1 | 1 ½ | 2 | 2 1/2 |
| Number of taps on pipe | | | | | |
| 4 | 100 | 1 | -- | -- | 1 |
| 6 | 200 | -- | 1 | -- | 1 |
| 8 | 400 | -- | 2 | 1 | 1 |
| 10 | 600 | -- | 3 | 2 | 1 |
| 12 | 900 | -- | -- | 3 | 2 |

- C. The Contractor shall be responsible to provide the water source for filling, flushing, and disinfecting the lines. Contractor shall provide all required temporary pumps, storage facilities required to complete the specified flushing and disinfection operations.
- D. The Contractor shall be responsible for the disposal of all water used to flush and disinfect the system in accordance with all governing rules and regulations. The discharge water shall not be allowed to create a nuisance for activities occurring on or adjacent to the site.

3.14 TESTING, OPERATIONAL PERFORMANCE AND ACCEPTANCE

- A. Provide the testing as indicated in previous sections of the Specifications.
- B. Demonstrate the operations of the systems as indicated in the Project Specifications.
- C. Acceptance shall be predicated upon a successful demonstration of the operation of the systems, as described, or demonstrating a fully functional system in automatic operation for a period of 7 days, whichever is more stringent.

3.15 MAINTENANCE

- A. Operate and maintain the irrigation system for a duration of 30 calendar days after Final Inspection. Make periodic examinations and adjustments to irrigation system components.

3.16 SPARE PARTS

- A. Upon completion of the Work furnish the COR the following for his maintenance stock:
 1. 10 – RB 8005 - sprinklers bodies
 2. 5 – RB 5000 MPR – sprinkler bodies
 3. 10 – #4 nozzles for 8005 rotors
 4. 5 – #6 nozzles for 8005 rotors
 5. 5 – #10 nozzles for 8005 rotors
 6. 5 – 35H nozzles for 5000 MPR sprinklers
 7. 5 – 35Q nozzles for 5000 MPR sprinklers

3.17 CLEANUP

- A. Upon completion of Work, remove from site all machinery, tools, excess materials, and rubbish. Restore site to normal or original condition.

END OF SECTION

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