

SECTION 328400 – PLANTING IRRIGATION

PART 1 – GENERAL

1.1 SCOPE

Furnish all labor, materials, supplies, equipment, tools, test apparatus, and transportation, and perform all operations in connection with and reasonably incidental to the complete installation of the irrigation system, and guarantee/warranty as shown on the drawings, the installation details, and as specified herein.

1.2 ITEMS OF WORK INCLUDED

Items of work specifically included are:

- A. Procurement of all applicable licenses, permits, and fees for all development, plant investment, or any other fees and permits associated with the purchase and installation of the taps.
- B. Coordination of Utility Location. ("Call before you dig"
- C. Verification of existing static and dynamic pressure
- D. Installation, connection of all sensors, and programming of irrigation controller.
- E. Installation and connection to irrigation central control system.
- F. Connection of electrical power supply to the irrigation controller and irrigation control system.
- G. Installation of sleeving from ground level landscape areas to on-structure landscape areas.
- H. Installation of sleeving within on-structure areas under pedestal paver systems.
- I. Maintenance period.
- J. Sleeving for irrigation pipe, control wire, communication wire, and other wire.

1.3 ITEMS OF WORK NOT INCLUDED

- A. Excavation, installation and backfill of tap into municipal water line.
- B. Excavation, installation and backfill of water meter and vault.
- C. Provision of electrical power supply to the irrigation controller and irrigation control system.

1.4 SUBMITTALS

- A. Submit samples under provisions of Contract Documents
- B. Deliver four (4) copies of all required submittals to the Owners' Representative within fifteen (15) days from the date of the Notice to Proceed.
- C. Materials List: Include, pipe, fittings, mainline components, water emission components, control system components and all other components needed to construct a fully operating automatic irrigation system. At a minimum include all components specifically identified on the irrigation drawings, irrigation legend, and in the irrigation details.. Quantities of materials need not be included.
- D. Manufacturers' Data: Submit manufacturers' catalog cuts, specifications, and operating instructions for equipment shown on the materials list. Highlight specific items to be utilized for construction of the irrigation system.
- E. Shop Drawings: Submit shop drawings called for in the installation details. Show products required for proper installation, their relative locations, and critical dimensions. Note modifications to the installation detail.
- F. Project Record Drawings: Submit project record (As-Built) drawings to Owner prior to commencement of maintenance period per Contract Documents. Accurate and complete project record drawings will be required before the maintenance period begins. Retainage will be held if project record drawings are not complete.

1.5 RULES AND REGULATIONS

- A. Work and materials shall be in accordance with the latest edition of the National Electric Code, the Uniform Plumbing Code as published by the Western Plumbing Officials Association, 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.

1.6 TESTING

- A. Notify the Owners' Representative three (3) business days in advance of testing.
- B. Pipelines jointed with rubber gaskets or threaded connections may be subjected to a pressure test at any time after partial completion of backfill. Pipelines jointed with solvent-welded PVC joints shall be allowed to cure a minimum of 24 hours before testing. Pipelines installed with thrust blocks shall have the concrete cured for a minimum of seven (7) days before testing.
- C. Subsections of mainline pipe may be tested independently, subject to the review of the Owners' Representative.
- D. Furnish clean, clear water, pumps, labor, fittings, and all equipment necessary to conduct tests or retests.
- E. The test pressure shall not exceed the rated working pressure of the pipe.
- F. Hydrostatic Pressure Test:
 - 1. Fill mainline pipe with water, purge all air out of the system. Subject mainline pipe to a hydrostatic pressure of 150 PSI for two hours. Test with mainline components installed. A 2 PSI pressure variation is allowed.
 - a. The use of an air compressor to provide pressure is not allowed.
 - 2. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
 - 3. Leakage will be detected by visual inspection. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat the test until the pipe passes test.
 - a. Cement or caulking to seal leaks is prohibited.
 - 4. The Owners' Representative reserves the option to furnish the gauges and metering devices for the tests.
- G. Volumetric Leakage Test:
 - 1. Cap risers of mainline components for volumetric pressure tests. Backfill to prevent pipe from moving under pressure. Expose couplings and fitting.
 - 2. Fill mainline pipe with water and purge all air from the pipeline before test.
 - 3. Subject mainline pipe to a hydrostatic pressure of 150 PSI for two hours. Maintain constant pressure.
 - a. The use of an air compressor to provide pressure is not allowed.
 - 4. The amount of additional water added to maintain constant pressure during the test shall not exceed the following amounts:

- a. The formula for calculating allowed leakage is:

$$i. \quad L = \frac{S \cdot D \cdot \sqrt{P}}{148,000}$$

L = Allowable leakage in Gallons Per Hour

S = Length of pipe in Feet

D = Nominal pipe diameter in Inches

P = Average test pressure, PSI

- ii. If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each pipe size and associated length.

5. Measure the volume of water using a calibrated container with a resolution of one (1) ounce of water.

	Allowable Leakage per 1000 feet of pipe* length - Gallons Per Hour										
	Nominal Pipe Diameter - Inches										
Test Pressure (PSI)	3	4	6	8	10	12	14	16	18	20	24
100	0.20	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62
125	0.23	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81
150	0.25	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99
175	0.27	0.36	0.54	0.72	0.89	1.07	1.25	1.43	1.61	1.79	2.15
200	0.29	0.38	0.57	0.76	0.96	1.15	1.34	1.53	1.72	1.91	2.29
	* If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.										

6. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat the test until the pipe passes test.
- a. Cement or caulking to seal leaks is prohibited.
7. The Owners' Representative reserves the option to furnish the gauges and metering devices for the tests.

H. Operational Test:

- Prior to the Operational Test connect and configure all system sensors.
 - The flow sensor shall be operational and operated per the manufacturer's instructions to learn the flow for all zones to be tested. The flow shall be stored in the controller's memory.
 - The master valve shall be installed and connected to the controller, and fully operational.
 - All rain, wind, temperature, weather or other sensors specified on the plan shall be installed, connected, and fully operational.
- Activate each remote-control valve in sequence from controller. The Owners' Representative will visually observe operation, water application patterns, and leakage.
- Replace defective remote-control valve, solenoid, wiring, or appurtenance to correct operational deficiencies.
- Replace, adjust, or move water emission devices to correct operation or coverage deficiencies.
- Replace defective pipe, fitting, joint, valve, sprinkler, or appurtenance to correct leakage problems.
 - Cement or caulking to seal leaks is prohibited.
- Repeat test(s) until each lateral passes all tests.

7. The Owners' Representative will measure and record static and dynamic pressure at the point of connection and in the system mainline at various locations.
8. The Owner's Representative will measure and record dynamic pressure at various sprinklers and water emission devices.

I. Central Control System Acceptance Test:

1. Upon completion of the centralized control system installation and Final Review, a System Acceptance Test must be passed.
2. Following Final Review, an evaluation period will commence. Upon completion of 30 days of continuous service without system problems, the system will be accepted, and the guarantee/warranty period will begin. If at any time during the 30-day evaluation period, a system problem occurs, the source of the problem will be determined, corrected and the 30-day evaluation period will start again. Equipment will not be accepted until such time as the System Acceptance Test is passed.
 - a. All central control system features, monitoring, reports, alerts, data collection, communication to all controllers and remote access shall be functional during the evaluation period.
3. If successful completion of the System Acceptance Test is not attained within 90 days following Final Review, the Owners' Representative has the option to request replacement of equipment, terminate the order, or portions thereof, or continue with the System Acceptance Test. These options will remain in effect until such time as a successful completion of the System Acceptance Test.
4. Final payment will be made after successful completion of the final System Acceptance Test.

J. Central Control Communication

1. Wired Communication:
 - a. Wired communication between the central control system, satellite controller and sensors shall be operational for thirty (30) days without operational interruptions. Communication components shall meet or exceed central control and controller system manufacturers specifications.
2. Wireless Communication:
 - a. Wireless communication between the central control system, satellite controller and sensors shall be operational for thirty (30) days without operational interruptions. Communication components shall meet or exceed central control and controller system manufacturers specifications.

1.7 CONSTRUCTION REVIEW

The purpose of on-site reviews by the Owners' Representative is to periodically observe the work in progress and the Contractor's interpretation of the construction documents and to address questions with regards to the installation.

- A. Scheduled reviews such as those for irrigation system layout or testing should be scheduled with the Owners' Representative as required by these specifications.
- B. Impromptu reviews may occur at any time during the project.
- C. Final review will occur at the completion of the irrigation system and Record Drawing (As-Built) submittal.

1.8 GUARANTEE/WARRANTY AND REPLACEMENT

The purpose of this guarantee/warranty is to ensure that the Owner receives irrigation materials of prime quality, installed and maintained in a thorough and careful manner.

- A. For a period of one year from commencement of the formal maintenance period, guarantee/warranty irrigation materials, equipment, and workmanship against defects. Fill and repair depressions. Restore landscape or structural features damaged by the settlement of irrigation trenches or excavations. Repair damage to the premises caused by a defective item. Make repairs within seven (7) days of notification from the Owners' Representative.

1. Costs for all guarantee/warranty work shall be entirely paid for by the Contractor.
- B. Contract documents govern replacements identically as with new work. Make replacements at no additional cost to the contract price.
- C. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.

PART 2: MATERIALS

2.1 QUALITY

Use material that are new and without flaws or defects of any type and are the best of their class and kind.

2.2 SUBSTITUTIONS

Pipe sizes referenced in the Construction Documents are minimum sizes and may be increased at the option of the Contractor. Substitutions in pressure class of pipe shall be approved by the Irrigation Designer.

2.3 IRRIGATION TAP AND WATER METER

- A. Provide materials required by local codes for installation of the municipal water tap and associated piping.
- B. Provide materials required by local code for installation of the water meter, vault and associated piping.

2.4 SLEEVING

- A. Install separate sleeve beneath paved areas to route each run of irrigation pipe or wiring bundle.
- B. Sleeving material beneath pedestrian pavements shall be PVC Class 200 bell end pipe with solvent welded joints.
- C. Sleeving beneath drives and streets shall be PVC Class 200 bell end pipe with solvent welded joints.
- D. Sleeving diameter: As indicated on the drawings and installation details or equal to twice the nominal diameter of the pipe or wiring bundle passing through.
- E.
 1. Furnish and install size sleeves for wiring bundles per the current NEC Conduit Fill calculations and charts.

2.5 PIPE AND FITTINGS

A. Mainline Pipe and Fittings:

1. Use rigid, unplasticized polyvinyl chloride (PVC) round pipe, National Sanitation Foundation (NSF) approved, extruded from material meeting the requirements of Cell Classification 12454 as defined in ASTM Standard D1784, with an integral belled end.
 - a. Use Class 200, SDR-21, rated at 200 PSI, conforming to the dimensions and tolerances established by ASTM Standard D2241 and ASTM Standard D2672. Use PVC pipe rated at higher pressures than Class 200 in the case of small nominal diameters which are not manufactured in Class 200.
 - b. Use rubber-gasketed pipe for mainline pipe with a nominal diameter greater than or equal to 3-inches and rubber-gasketed ductile iron fittings with water-based lubricant approved by the pipe manufacturer. All gasket seals shall meet the requirements of ASTM Standard D3139 and the gasket material shall meet and/or exceed the requirements of ASTM Standard F477 for elastomeric seals.
 - i. Use gasketed pipe and fittings equipped with Rieber Gasket System.

- c. Use solvent weld pipe for mainline pipe with a nominal diameter less than 3-inches or where a pipe connection occurs in a sleeve. Use Schedule 40, Type 1, Cell Classification 12454, PVC solvent weld fittings conforming to ASTM Standard D1784 and ASTM Standard D2466. All belled end pipe shall have tapered sockets to create an interference type fit, which meet or exceed the dimensional requirements and minimum socket length for pressure type sockets as defined by ASTM Standard 2672. Use primer specifically approved by the pipe manufacturer. Solvent cement to conform to ASTM Standard D2564.

B. Lateral Pipe and Fittings:

1. Use rigid, unplasticized polyvinyl chloride (PVC) round pipe, National Sanitation Foundation (NSF) approved, extruded from material meeting the requirements of Cell Classification 12454 as defined in ASTM Standard D1784, with an integral belled end.
2. Use Class 200, SDR-21, rated at 200 PSI, conforming to the 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 that are not manufactured in Class 200. All belled end pipe shall have tapered sockets to create an interference type fit, which meet or exceed the dimensional requirements and minimum socket length for pressure type sockets as defined by ASTM Standard 2672.
3. Use primer approved by the pipe manufacturer. Solvent cement to conform to ASTM Standard D2564, of a type approved by the pipe manufacturer.
 - a. Solvent welded pipe shall not be installed when the outside temperature drops below forty-five (45) degrees Fahrenheit.
4. For drip irrigation laterals downstream of remote control valves, use UV radiation resistant polyethylene pipe manufactured from Dow Chemical FINGERPRINT DFDA-7510NT polyethylene resin manufactured by Dow Chemical or a Dow Chemical Licensee with a minimum of 2% carbon black or approved UV stabilizer, and minimum nominal pipe ID dimension of 0.810" for 3/4-inch pipe.
 - a. Use Type 1, cell classification 12454PVC as defined in ASTM Standard D1784 insert fittings conforming to ASTM Standard D2609 designed for use with flexible polyethylene (PE) pipe.

C. Specialized Pipe and Fittings

1. Copper pipe: Use Type K drawn temper (hard or rigid) copper pipe conforming to ASTM Standard B88.
 - a. Use wrought copper or cast bronze fittings that are dezincification resistant and conform to ASTM Standard B75, soldered or threaded per the installation details. Use a 95% tin and 5% antimony solder. Use a thread sealant approved by the pipe manufacturer.
2. Galvanized steel pipe: Use Schedule 40 conforming to ASTM Standard A123.
 - a. Use galvanized, threaded, Class 150, malleable iron fittings conforming to ASME Standard B16.3 and ASTM Standard A123.
3. Ductile iron pipe: Use ductile iron pipe with a minimum pressure class rating of 200 PSI and meeting the requirements of ANSI/AWWA Standard C151/A21.51 and ANSI/AWWA Standard C150/A21.50.
 - a. Use ductile iron fittings with a minimum pressure class rating of 200 PSI and meeting the requirements of ANSI/AWWA Standard C153/A21.53.
 - b. Rubber Gasket joints shall meet the requirements of ANSI/AWWA Standard C111/A21.11.
 - c. Install all ductile iron pipe in accordance with ANSI/AWWA Standard C600.
4. Use a dielectric union wherever a copper-based metal (copper, brass, bronze) is joined to an iron-based metal (iron, galvanized steel, stainless steel).

5. Assemblies calling for pre-fabricated swing joints shall utilize SPEARS swing joints or approved equal. Swing joints shall be rated at 315 psi, and use O-ring, Buttress thread and street elbow construction.
6. Inline Emitter Drip Tubing:
 - a. Provide a low volume dripper line with integral and evenly spaced pressure compensating drippers at specified intervals in a discharge rate specified in the plans and drawings. Inline Emitter Drip Tubing shall consist of nominal sized one-half inch low-density linear polyethylene tubing. The Inline Emitter Drip Tubing shall have internal pressure compensating, continuous self-cleaning, integral drippers at a specified spacing of 12" on center with a built-in check valve capable of holding up to 8.5 feet of water, or blank tubing without drippers where specified in detail.
 - i. Inside diameter: 0.57 inches
 - ii. Outside diameter: 0.67 inches
 - iii. Color: Brown/Black/Purple
 - b. Use spiral barb fittings supplied by the same manufacturer as the inline emitter drip tubing. Use tubing stakes supplied by the same manufacturer as the inline emitter drip tubing.
 - c. All tubing shown outside of the bed area shall be Class 200 PVC pipe.
7. Low Density Polyethylene Hose:
 - a. Use pipe specifically intended for use as a flexible swing joint.
 - i. Inside diameter: 0.490+0.010 inch
 - ii. Wall thickness: 0.100+0.010 inch
 - iii. Color: Black
 - iv. Pressure Rating: 80 PSI
 - b. Use spiral barb fittings supplied by the same manufacturer as the hose.
8. Assemblies calling for threaded pipe connections shall utilize PVC Schedule 80 nipples and PVC Schedule 80 threaded fittings.
9. Joint sealant:
 - a. Use only Teflon-type tape pipe joint sealant on plastic threads. Use nonhardening, nontoxic pipe joint sealant formulated for use on water-carrying pipes on metal threaded connections.
10. Marking Tape:
 - a. Mainline Pipe - Christy underground I.D. tape TA.DT.6.P.NPW.

2.6 MAINLINE COMPONENTS

- A. Main System Shutoff Valve: As per local practice and in compliance with local code.
- B. Winterization Assembly: As per local practice and in compliance with local code.
- C. Backflow Prevention Assembly: As presented in the installation details and in compliance with local code.
- D. Master Valve Assembly: As presented in the installation details.
- E. Flow Sensor Assembly: As presented in the installation details.
- F. Isolation Gate Valve Assembly: As presented in the installation details. Install a separate valve box over a 3-inch depth of 3/4-inch gravel for each assembly.
- G. Quick Coupling Valve Assembly: Double swing joint arrangement as presented in the installation details. Install at a height where key can be inserted, turned and valve pressurized without removing threaded handle.
- H. Combination Pressure Regulator/Wye-Strainer Assembly: As presented in the installation details. Install a separate valve box over a 3-inch depth of 3/4-inch gravel for each assembly.

- I. Pressure Regulator Assembly: As presented in the installation details. Install a separate valve box over a 3-inch depth of 3/4-inch gravel for each assembly.
- J. Wye-Strainer Assembly: As presented in the installation details. Install a separate valve box over a 3-inch depth of 3/4-inch gravel for each assembly.

2.7 DRIP IRRIGATION COMPONENTS

A. Remote Control Valve (RCV) Assembly for Drip Laterals:

- 1. As presented in the installation details. Use wire connectors and waterproofing sealant to join control wires to solenoid valves. Use standard identifications tags marked with controller name and station number. Install a separate valve box over a 3-inch depth of washed pea gravel for each assembly. Use 8-ounce minimum weight non-woven geotextile fabric underneath pea gravel and box assembly to prevent dirt and debris intrusion. Adjust valve flow control per manufacturer's recommendations prior to use.

B. Zone Control Valve Assembly:

- 1. As presented in the installation details. Install a separate box over a 3-inch depth of pea gravel for each assembly. Use 8-ounce minimum weight non-woven geotextile fabric underneath pea gravel and box assembly to prevent dirt and debris intrusion.

C. Drip Emitter Assembly:

- 1. Barb-mounted, vortex and/or pressure compensating emitter device as presented in the installation details. The device shall be Rain Bird Xeri-Bug XB-10PC series.
- 2. Install emitter types and quantities on the following schedule:
 - a. Ground cover plant: 1 single outlet emitter each or 1 single outlet emitter per square foot of planting area, whichever is less.
 - b. Shrub: 2 single outlet emitters each.
 - c. Tree: 4 single outlet emitters each or 1 multi-outlet emitter each (with 4 outlets open).
- 3. Use 1/4-inch diameter flexible plastic tubing to direct water from emitter outlet to emission point. Length of emitter outlet tubing shall not exceed five feet. Secure emitter outlet tubing with tubing stakes and install bug cap, both items manufactured by emitter manufacturer.
- 4. Install an access sleeve for each multiple-outlet emitter located in a turf area.

D. Flush Cap Assembly

- 1. As presented in the installation details. Locate at the end of each drip irrigation lateral pipe. Install a separate valve box over a 3-inch depth of pea gravel for each assembly. Use 8-ounce minimum weight non-woven geotextile fabric underneath pea gravel and box assembly to prevent dirt and debris intrusion.

E. Drip Operation Indicator

- 1. As presented in the installation details. Install at the most remote dead ends of UV radiation resistant polyethylene tubing. Install in area easily accessible for maintenance and visibility. Minimum of 8-inch indicator pop up height.

2.8 CONTROL SYSTEM COMPONENTS

A. Irrigation Controller Unit:

- 1. As presented in the drawings and installation details.
 - a. As manufactured by Weathermatic, Garland, Texas 75041
- 2. Primary surge protection arrestors:
 - a. Per controller manufacturer.
- 3. Valve output surge protection arrestors:

- a. Per controller manufacturer.

B. Instrumentation

1. As presented in the drawings and installation details.
2. Rain Sensor: RFS5 as manufactured by Weathermatic, Garland, Texas 75041
3. Flow Sensor: QS200-XX as manufactured by Flomec, Inc. Sized per drawings.

C. Control Wire:

1. Use American Wire Gauge (AWG) No.12/14 solid copper conforming to ASTM B-3 or ASTM B-8. Type UF or PE cable, UL approved for direct underground burial from the controller unit to each remote-control valve. Use American Wire Gauge (AWG) No.12 wire for common wire.
 - a. Type PE Cable:
 - i. Minimum temperature rating of 60° C and 600 volts.
 - ii. Minimum insulation thickness of 0.060".
 - iii. Sunlight resistant, testing at 300 hours of carbon-arc or xenon-arc exposure.
 - iv. Cold Bend Test: Insulation shall not show any cracks when sample is bent around a 3X mandrel after being subjected to minus 25° C for four (4) hours.
 - v. Insulation shall not absorb more than 25mg mass of water per square inch.
 - b. Type UF/TWU Cable:
 - i. Minimum temperature rating of 60° C and 600 volts.
 - ii. Minimum insulation thickness of 0.060" for wires 14AWG to 10AWG, minimum insulation thickness of 0.080" for wires 8AWG to 2AWG.
 - iii. Cold Bend Test: Insulation shall not show any cracks when sample is bent around a 3X mandrel after being subjected to minus 25° C for four (4) hours.
2. Wire Color for Two-Wire Controllers:

a. Primary Path		Blue
b. Secondary Path	Red	
c. Tertiary Path		Orange
d. Quaternary Path	Yellow	
e. Quinary Path		Black
3. Splices: Use wire connectors with waterproof sealant. Wire connector to be of UV radiation resist plastic construction consisting of two pieces, one piece which snap locks into the other. Connector shall be pre-filled with non-hardening silicone gel. Utilize twist style wire connector provided with assembly to connect wires.
 - a. Wire connectors to meet requirements of UL Standard 486D
 - b. Utilize DBR/Y-600 Black Splices
4. Encase wiring not located near PVC irrigation pipe in PVC Schedule 80 electrical conduit. Utilize long sweep elbows for changes of direction.
5. Warning tape: Detectable inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. Tape shall be six inches wide, colored purple.
6. Existing Control Wire: It is assumed that existing 24 VAC control wire, two-wire paths and sensor wire between existing controller sensors and between the controllers and solenoid valves is in workable condition. Any concerns are to be brought to the attention of the Owner prior to installation of the replacement controller.

7. Contractor shall verify the condition and operation of any existing control wire or sensor wire prior to replacement of the controller at no additional cost. If existing control wire or sensor wire requires replacement contractor shall inform owner of the impact to the cost and schedule of the project.

2.9 OTHER COMPONENTS

- A. Tools and Spare Parts: Provide operating keys, servicing tools, test equipment, other items and spare parts indicated in the General Notes of the drawings.
 1. Additionally, provide the following:
 - a. Two operating keys for each type and size of manually operated valve.
 - b. Two keys for each type and size of quick coupler.
 - c. Two of each servicing wrench or tool needed for complete access, adjustment, installation of nozzles and repair of all spray, rotary and rotor type sprinklers.
 - d. Two 3" diameter pressure gauges and associated fittings to measure system pressure and pressure at spray, rotary and rotor type sprinklers and remote-control valves. Pressure gauge shall have a range of 0-160 PSI.
 - e. Two sets of keys for each controller, enclosure or equipment that requires keyed access.
 - i. If required, keys shall be keyed to match other locks that the Owner possess.
 - f. All instruction manuals, repair manuals, operating manuals and original paper work related to the products that were installed during construction of the irrigation system.
 2. Owner Stock: Include the following for owner stock for future replacements.
 - a. Ten (10) of each type and size of rotor nozzle.
 - b. Three (3) of each type of drip operation indicator.
 - c. Ten (10) of each type of drip emitter.
 - d. Five (5) of each type of surge protector/arrestor.
 - e. 100-feet continuous length of inline emitter drip tubing of each flow rate and inline emitter spacing.
 - f. Ten (10) sets of waterproof connectors.
 - g. Five (10) of each type and size of fitting; inline emitter, drip lateral, and mainline.

PART 3: EXECUTION

3.1 INSPECTION AND REVIEWS

- A. Site Inspections:
 1. Verify site conditions and note irregularities affecting work of this section. Report irregularities to the Owners' Representative prior to beginning work.
 2. Beginning work of this section implies acceptance of all existing conditions.
 3. Contractor will be held responsible for coordination between landscape and irrigation system installation.
 4. Landscape material locations shown on the Landscape Plan shall take precedence over the irrigation system equipment locations. If irrigation equipment is installed in conflict with the landscape material locations shown on the Landscape Plan, the Contractor will be required to relocate the irrigation equipment, as necessary, at Contractor's expense.
- B. Utility Location (Call Before You Dig)
 1. Arrange for and coordinate with local authorities the location of all underground utilities.
 2. Repair any underground utilities damaged during construction. Make repairs at no additional cost to the contract price.

- C. Irrigation System Layout Review: Irrigation system layout review will occur after the staking has been completed. Notify the Owners' Representative three business days in advance of review. Modifications will be identified by the Owners' Representative at this review.

3.2 LAYOUT OF WORK

- A. Stake out the irrigation system. Items staked shall include: Sprinklers, pipe, control valves, manual drains, controller, and isolation valves, grounding locations and sleeving.
- B. Install all mainline pipe and mainline components inside of project property lines.

3.3 EXCAVATION, TRENCHING AND BACKFILLING

- A. Excavate to permit the pipes to be laid at the intended elevations and to permit work space for installing connections and fittings.
- B. Minimum cover (distance from top of pipe or control wire to finish grade):
 - 1. 24-inch over mainline pipe and over electrical conduit.
 - 2. 26-inch over control wire.
 - 3. 26-inch over signal wire.
 - 4. 18-inch over lateral pipe to inline drip.
 - 5. 8-inch over drip lateral pipe in turf or paved areas downstream of drip system zone control valves.
 - 6. 3-inch minimum mulch cover over drip lateral pipe in planting beds downstream of drip system zone control valves. PVC UV radiation resistant lateral pipe shall be installed directly on the soil surface under landscape fabric.
- C. Backfill only after lines have been reviewed and passed hydrostatic tests and accepted by the Owner.
- D. Excavated material is generally satisfactory for backfill. Backfill shall be free from rubbish, vegetable matter, frozen materials, and stones larger than 1/2-inch in maximum dimension. Remove material not suitable for backfill. Backfill placed next to pipe shall be free of sharp objects which may damage the pipe. All soil shall be screened and pass through a square opening 1/2" x 1/2".
- E. Backfill unsleeved pipe and sleeves in either of the following manners:
 - 1. Backfill and puddle the lower half of the trench. Allow to dry 24 hours. Backfill the remainder of the trench in 6-inch layers. Compact to density of surrounding soil.
 - 2. Backfill the trench by depositing the backfill material equally on both sides of the pipe in 6-inch layers and compacting to the density of surrounding soil.
- F. Enclose pipe and wiring beneath roadways, walks, curbs, etc. in sleeves. Minimum compaction of backfill for sleeves shall be 95% Standard Proctor Density, ASTM D698-78. Conduct one compaction test for each sleeved crossing less than 50 feet long. Conduct two compaction tests for each sleeved crossing greater than 50 feet long. Costs for such testing and any necessary retesting shall be paid for by the Contractor. Use of water for compaction around sleeves, puddling, will not be permitted.
- G. Dress backfilled areas to original grade
- H. Where utilities conflict with irrigation trenching and pipe work, contact the Owners' Representative for trench depth adjustments.

3.4 SLEEVING AND BORING

- A. Install sleeving at a depth which permits the encased pipe or wiring to remain at the specified burial depth.
- B. Extend sleeve ends six inches beyond the edge of the paved surface. Cover pipe ends and mark with stakes. Mark concrete with a chiseled "X" at sleeve end locations.
- C. Bore for sleeves under obstructions which cannot be removed. Employ equipment and methods designed for horizontal boring.

3.5 ASSEMBLING PIPE AND FITTINGS

A. General:

1. Keep pipe free from dirt and pipe scale. Cut pipe ends square and deburr. Clean pipe ends.
2. Keep ends of assembled pipe capped to prevent dirt and debris intrusion. Remove caps only when necessary to continue assembly.

B. Mainline Pipe and Fittings:

1. Use only strap-type friction wrenches for threaded plastic pipe. Tighten threaded plastic pipe per pipe and fitting manufacturers recommendations.
2. PVC Rubber-Gasketed Pipe:
 - a. Use pipe lubricant. Join pipe in the manner recommended by manufacturer and in accordance with accepted industry practices.
 - b. Epoxy-coated steel fittings shall not be struck with a metallic tool. Cushion blows with a wood block or similar shock absorber.
3. PVC Solvent Weld Pipe:
 - a. Use primer and solvent cement. Join pipe in a manner recommended by the manufacturer and in accordance with accepted industry practices.
 - b. Cure for 30 minutes before handling and 24 hours before allowing water in pipe.
 - c. Snake pipe from side to side within the trench.
4. Fittings: The use of cross type fittings is not permitted.

C. Lateral Pipe and Fittings:

1. Use only strap-type friction wrenches for threaded plastic pipe. Tighten threaded plastic pipe per pipe and fitting manufacturers recommendations.
2. PVC Solvent Weld Pipe:
 - a. Use primer and solvent cement. Join pipe in the manner recommended by the manufacturer and in accordance with accepted industry practices.
 - b. Cure for 30 minutes before handling and 24 hours before allowing water in the pipe.
 - c. Snake pipe from side to side within the trench.
3. Polyethylene (PE) Pipe:
 - a. Join pipe in the manner recommended by manufacturer and in accordance with accepted industry practices.
 - b. Snake pipe from side to side within the trench.
4. UV Radiation Resistant Polyethylene Pipe:
 - a. Join pipe in the manner recommended by manufacturer and in accordance with accepted industry practices.
 - b. Snake pipe from side to side within the trench, on the soil surface, and hold in place with tubing stakes spaced every five feet.
5. Fittings: The use of cross type fittings is not permitted.

D. Specialized Pipe and Fittings:

1. Copper Pipe:
 - a. Buff surfaces to be joined to a bright finish. Coat with solder flux.

- b. Solder so that a continuous bead shows around the joint circumference.
- 2. Galvanized Steel Pipe:
 - a. Join pipe in the manner recommended by manufacturer and in accordance with accepted industry practices.
 - b. Use factory-made threads whenever possible. Field-cut threads will be permitted only where necessary. Cut threads on axis using clean, sharp dies.
 - c. Apply Teflon-type tape or pipe joint compound to the male threads only.
- 3. Ductile Iron Pipe:
 - a. Use push-on joints whenever possible. Use pipe lubricant. Join pipe in the manner recommended by manufacturer and in accordance with accepted industry practices.
 - b. Insert a dielectric union wherever a copper-based metal (copper, brass, bronze) and an iron-based metal (iron, galvanized steel, stainless steel) are joined.
- 4. Pre-fabricated double swing joints: Install per manufacturer's recommendations.
- 5. Low Density Polyethylene Hose: Install per manufacturer's recommendations.
- 6. PVC Threaded Connections:
 - a. Use only factory-formed threads. Field-cut threads are not permitted.
 - b. Use only thread sealant recommended by pipe and fitting manufacturer.
 - c. When connection is plastic-to-metal, the plastic component shall have male threads and the metal component shall have female threads.
- 7. Make metal-to-metal, threaded connections with Teflon-type tape or pipe joint compound applied to the male threads only.

INSTALLATION OF MAINLINE COMPONENTS

- A. Main System Shut Off Valve: Install where indicated on the drawings.
- B. Winterization Assembly: Install where indicated on the drawings.
- C. Backflow Prevention Assembly: Install where indicated on the drawings. Install assembly so that its elevation, orientation, access, and drainage conform to the manufacturer's recommendations and applicable health codes.
- D. Master Valve Assembly: Install where indicated on the drawings.
- E. Flow Sensor Assembly: Install where indicated on the drawings.
- F. Isolation Gate Valve Assembly:
 - 1. Install where indicated on the drawings.
 - 2. Locate at least 12-inches from and align with adjacent walls or edges of paved areas.
- G. Quick Coupling Valve Assembly: Install where indicated on the drawings.
- H. Combination Pressure Regulator/Wye-Strainer Assembly: Install where indicated on the drawings.
- I. Pressure Regulator Assembly: Install where indicated on the drawings.
- J. Wye Strainer Assembly: Install where indicated on the drawings.
- K. Manual Drain Valve Assembly: Install where indicated on the drawings and at other low points in the mainline piping. Determine additional low points after staking mainline and approve locations with Owner.

- L. Air/Vacuum Relief Valve Assembly: Install where indicated on the drawings and at other high points in the mainline piping. Determine additional high point after staking mainline and approve locations with Owner.

3.7 INSTALLATION OF DRIP IRRIGATION COMPONENTS

A. Remote Control Valve (RCV) Assembly for Drip Laterals

1. Flush mainline pipe before installing RCV assembly.
2. Locate as shown on the drawings. Wire connectors and waterproof sealant shall be used to connect control wires to remote control valve wires. Connectors and sealant shall be installed as per the manufacturer's recommendations.
3. Install only one RCV to valve box. Locate at least 12-inches from and align with nearby walls or edges of paved areas. Group RCV assemblies together where practical.
4. Arrange grouped valve boxes in rectangular patterns.

B. Drip Emitter Assembly:

1. Locate as shown on the drawings and installation details.
2. Flush lateral pipe before installing emitter assembly.
3. Cut emitter outlet distribution tubing square.
4. Install an access sleeve as part of each multiple-outlet emitter assembly for emitters located in turf areas.
5. Use tools and techniques recommended by the manufacturer. Make openings for barb-mounted emitters with the emitter manufacturer's hole-punching tool.

- C. Flush Cap Assembly: Install at the end of each drip irrigation lateral pipe as shown on the installation details.

3.8 INSTALLATION OF CONTROL SYSTEM COMPONENTS

A. Irrigation Controller Unit:

1. The location of the controller unit as depicted on the drawings is approximate; the Owners' Representative will determine the exact site location upon commencement of contract. during sprinkler layout review.
2. Lightning protection: Ground rods are to have a minimum diameter of 3/4" and a minimum length of 10 feet. These are to be driven into the ground in a vertical position or an oblique angle not to exceed 15 degrees at location 10 feet from the electronic equipment, the ground plate, or the wires and cables connected to said equipment, as shown in the irrigation details. The rod is to be stamped with the UL logo. A 6 AWG solid bare copper wire (no more than 12 feet long) shall be connected to the ground rod by the installer using a UL approved grounding clamp. This wire shall be connected to the electronic equipment ground lug as shown in the detail above.
3. Lightning protection: Provide on all remote-control valve wiring as recommended by the manufacturer. Provide other components such as ground rod, grounding wire, etc., to manufacturer's recommendations.
4. Install primary surge protection arrestors on incoming power lines.
5. Install one valve output surge protection arrestor on each control wire and one for the common wire.
6. 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.
7. Connect control wires to the corresponding controller terminal.

B. Instrumentation:

1. Install sensors per the installation details and manufacturer's recommendations. Install at locations shown on the drawings.
2. Install electrical connections between irrigation controller and sensors per manufacturer's recommendations.

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. 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. Make wiring loop by turning control wire 5 turns around 1-inch pipe. Coil 24-inch length of wire within each remote-control valve box.
3. Install common ground wire and one control wire for each remote-control valve. Multiple valves on a single control wire are not permitted.
4. If a control wire must be spliced, make splice with wire connectors and waterproof sealant, installed per the manufacturer's instructions. Locate splice in a valve box which contains an irrigation valve assembly, or in a separate 6-inch round valve box. Use same procedure for connection to valves as for in-line splices.
5. Unless noted on plans, install wire parallel with and under PVC mainline pipe. If wire is installed adjacent to section of metal pipe, separate wire from pipe minimum of 6-inches and install wire in PVC conduit.
6. Encase wire not installed with PVC mainline pipe in electrical conduit.

3.9 INSTALLATION OF CENTRAL CONTROL SYSTEM COMPONENTS

A. Central Control Unit:

1. The location of the central control unit as depicted on the drawings is approximate; the Owners' Representative will determine the exact location upon commencement of contract during sprinkler layout review.
2. Install and test central control components including computer, interface components, and communication hardware per manufacturer's recommendations.
3. Communication: Coordinate installation of all communications connections local authorities having jurisdiction.

B. Satellite Control Units:

1. The locations of the control units as depicted on the drawings are approximate; the Owners' Representative will determine their exact site locations upon commencement of contract during sprinkler layout review.
2. Install electrical connections between central control unit components and satellite control units per manufacturer's recommendations. Wire connections in the field are to be installed by the manufacturer's personnel or trained distributor personnel.
3. Lightning protection: Drive 3/4" x 10-foot copper-clad grounding rod into the soil. If rock prevents driving, bury at least four feet deep. A single rod may be used for grouped control units. Connect controller to grounding rod with AWG No. 6 solid conductor copper wire. Secure wire to grounding rod with brass or bronze clamp. Locate the connection in a separate valve box.
4. Lightning protection: Provide on all remote-control valve wiring as recommended by the manufacturer. Provide other components such as ground rod, grounding wire, etc., to manufacturer's recommendations.
5. Install primary surge protection arrestors on incoming power lines.
6. Install one valve output surge protection arrestor on each control wire and one for the common wire.

7. 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.
8. Connect control wire to the corresponding control unit terminal.

C. Instrumentation:

1. Install sensors per the installation details and manufacturer's recommendations. Install at locations shown on the drawings.
2. Install electrical connections between central control unit components and sensors per manufacturer's recommendations.

D. Signal Wire:

1. Route signal wire as directed on plans. Install with a minimum number of field splices.
2. All signal wire shall be laid in trenches. The use of a vibratory plow is not permitted.
3. Carefully backfill around signal wire to avoid damage to wire insulation or wire connectors.
4. If a signal wire must be spliced, make splice with recommended connector, installed per manufacturer's recommendations. Locate all splices in a separate 6-inch round valve box. Coil 2 feet of signal wire in valve box.
5. Unless noted on plans, install wire parallel with and under PVC mainline pipe. If wire is installed adjacent to section of metal pipe, separate wire from pipe minimum of 6-inches and install wire in PVC conduit.
6. Encase wire not installed with PVC mainline pipe in electrical conduit.

E. 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. If a control wire must be spliced, make splice with wire connectors and waterproof sealant, installed per the manufacturer's instructions. Locate splice in a valve box which contains an irrigation valve assembly, or in a separate 6-inch round valve box. Use the same procedure for connection to valves as for in-line splices.
6. Unless noted on plans, install wire parallel with and under PVC mainline pipe. If wire is installed adjacent to section of metal pipe, separate wire from pipe minimum of 6-inches and install wire in PVC conduit.
7. Encase wire not installed with PVC mainline pipe in electrical conduit.

3.10 INSTALLATION OF OTHER COMPONENTS

A. Tools and Spare Parts:

1. Prior to the Pre-Maintenance Review, supply to the Owner operating keys, servicing tools, test equipment, and any other items indicated on the drawings.
2. Prior to Final Review, supply to the Owner the spare parts indicated in the General Notes on the drawings.

3. Other Materials: Install other materials or equipment shown on the drawings or installation details to be part of the irrigation system, even though such items may not have been referenced in these specifications.

3.11 PROJECT RECORD (AS-BUILT) DRAWINGS

- A. Maintain on-site and separate from documents used for construction, one complete set of contract documents as Project Documents. Keep documents current. Do not permanently cover work until as-built information is recorded.
- B. Record pipe and wiring network alterations. Record work which is installed differently than shown on the construction drawings. Record accurate reference dimensions, measured from at least two permanent reference points, of each irrigation system valve, each backflow prevention device, each controller or control unit, each sleeve end, each stub-out for future pipe or wiring connections, and other irrigation components enclosed within a valve box.
- C. Prior to Final Review, obtain from the Owners' Representative an electronic copy of the drawings. Using appropriate editing software, exactly duplicate information contained on the project drawings maintained on-site. Label each sheet "Record Drawing". Completion of the Record Drawings will be a prerequisite for the Final Review.

3.12 MAINTENANCE

- A. Upon completion of Final Review, maintain irrigation system for a duration of 30 calendar days. Make periodic examinations and adjustments to irrigation system components to achieve the most desirable application of water.
- B. Following completion of the Contractor's maintenance period, the Owner will be responsible for maintaining the system in working order during the remainder of the guarantee/warranty period, for performing necessary minor maintenance, for trimming around sprinklers, for protecting against vandalism, and for preventing damage during the landscape maintenance operation.

3.13 CLEAN-UP

- A. Upon completion of work, remove from the site all machinery, tools, excess materials, and rubbish.

END OF SECTION