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SECTION 32 84 23 – IRRIGATION

PART 1:GENERAL

1.01 SCOPE:

Furnish all labor, materials, supplies, equipment, tools, transportation, and perform all operation 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. Items of work specifically included are:

- I. Procurement of all applicable licenses, permits, and fees.
- II. Coordination of Utility Locates (One Call 1-800-849-2476).
- III. Coordination for, and provision of, testing of the signal between new controller location and the central control computer prior to construction to ensure that effective communication exists with the Gillette Hospital central control system. (If applicable)
- IV. Connection of electrical power supply to the irrigation control system.
- V. Sleeving for irrigation pipe and wire.
- VI. Preparation of Record Drawings.
- VII. Winterization and Spring Start-up.
- VIII. Maintenance period.

1.02 WORK NOT INCLUDED:

Items of work specifically excluded or covered under other sections are:

- I. Provision for electrical power supply to the irrigation control system.

1.03 SUBMITTALS

- I. Deliver four (4) copies of all submittals to the Project Manager within 10 working days from the date of Notice to Proceed. Provide information in a 3-ring binder with table of contents and index sheet. Provide sections that are indexed for different components and labeled with the specification section numbered and the name of the component. Submittals must be made for all the components on the material list. Indicate which items are being supplied on the catalog cut sheets when multiple items are shown on one sheet. Submittal package must be complete prior to being reviewed by the Project Manager. Incomplete submittals will be returned without review.
- II. Materials List: Include sleeving, pipe, fittings, mainline components, sprinkler heads, drip irrigation components, control system components, shop drawings and all other components shown on the drawings and installation details or described herein. Components such as pipe sealant, wire, wire connectors, ID tags, etc. must be included. Quantities of materials need not be included.
- III. Manufactures' Data: Submit manufactures' catalog cuts, specifications, and operating instructions for equipment shown on the materials list.
- III. 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.

1.04 RULES AND REGULATIONS

- I. 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, City of Gillette Design Standards Criteria and City of Gillette Standard Construction Specifications, and applicable laws and regulation of the governing authorities.

- II. 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.
- III. 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.
- IV. Notify Project Manager in writing prior to construction about discrepancies between contract documents and existing site conditions or manufacturer's specific recommendations for use or their product.
- V. Contractor is responsible for damage to site amenities during construction. Replace damaged items with identical materials of equal value to match existing conditions. Make replacements at no additional cost to contract price. Penalty for specific damage: as valued by an independent auditor or as mutually agreed to by Owner and Contractor.

1.05 QUALITY ASSURANCE

- I. Engage an experienced Installer who has completed irrigation work similar in materials, design, and extent to that indicated for this project and with a record of successful irrigation installations.
- II. Installer's Field Supervision: Installer shall have as their field supervisor, a person with a minimum of three years experience installing projects of similar scope and size. This person shall be on the project site full-time when landscaping is in progress.

1.06 TESTING

- I. Notify the Project Manager three days in advance of testing.
- II. Pipelines jointed with rubber gaskets or threaded connection 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 at least 24 hours before testing.
- III. Subsections of mainline pipe may be tested independently, subject to the review of the Project Manager.
- IV. Furnish clean, clear water, pumps, labor, fittings, and equipment necessary to conduct test or retests.
- V. All costs, including travel expenses for site visits by the Project Manager or Consultant, for any re-inspection that may be required due to non-compliance with the Construction Documents shall be the sole responsibility of the Contractor.
- VI. Hydrostatic Pressure Test (Solvent Weld Mainline Pipe)
 - A. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
 - B. Expose all remote control valves their riser pipe and service tee fittings.
 - C. Purge air from mainline pipe before test. Attach pressure gauge to mainline pipe in test section.
 - D. Subject mainline pipe to a hydrostatic pressure equal to 140 PSI for two hours. Test with mainline components installed.
 - E. Observe pressure loss on pressure gauge. If pressure loss is greater than 5 PSI, identify reason for pressure loss. Visually inspect irrigation pipe for leakage and replace defective pipe, fitting, joint, valve, or appurtenance. Repeat test until pressure loss is equal to or less than 5 PSI.
 - F. Cement or caulking to seal leaks is prohibited.
- VII. Volumetric Leakage Test (Mainline Pipe with Rubber Gaskets)
 - A. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
 - B. Purge air from pipeline before tests.
 - C. Provide all necessary pumps, bypass piping, storage tanks, meters, 3-inch test gauge, supply piping and fittings in order to properly perform testing.
 - D. Subject mainline pipe to 140 PSI for two hours. Maintain constant pressure.

- E. Testing pump must provide a continuous 140 PSI to the mainline. Allowable deviation in test pressure is 5 PSI during test period. Restore test pressure to 140 PSI at end of test.
- F. Water added to mainline pipe must be measured volumetrically to the nearest 0.10 gallons.
- G. Use the following table to determine maximum allowable volume lost during test:

Leakage Allowable (Gallons per 100 joints/Hour)

Pipe Size (INCHES)	Test Pressure (PSI)								
	60	70	80	90	100	110	120	130	140
3"	0.48	0.51	0.55	0.58	0.62	0.65	0.68	0.70	0.73
4"	0.62	0.66	0.71	0.75	0.8	0.84	0.87	0.91	0.94
6"	0.90	0.97	1.04	1.11	1.18	1.23	1.29	1.34	1.40

VIII. Operational Test

- A. Activate each remote control valve in sequence from controller. The Project Manager will visually observe operation, water application patterns, and leakage.
- B. Replace defective remote control valves, solenoids, wiring, or appurtenance to correct operational deficiencies.
- C. Replace, adjust, or move water emission devices to correct operational or coverage deficiencies.
- D. Replace defective pipe, fittings, joint, valves, sprinkler, or appurtenance to correct leakage problems. Cement or caulking to seal leaks is prohibited.
- E. Repeat test(s) until each lateral passes all tests. Repeat tests, replace components, and correct deficiencies at no additional cost to the City.

IX. Control System Acceptance Test

- A. Upon completion of construction, City of Gillette Parks Division Representatives will administer a System Acceptance Test.
- B. Following construction completion and a Review by the Project Manager, an evaluation period will begin. After 30 days of continuous service without major 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 major system problem occurs, the source of the problem will be determined and 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.
- C. If successful completion of the System Acceptance Test is not attained within 90 days following commencement of the evaluation period, the Project Manager 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.
- D. Final payment will be made after successful completion of the System Acceptance Test.

X. Sensor Cable

- A. Test for leaks to ground per manufacturer's recommendations. Test results must meet or exceed manufacturer's guidelines for acceptance.
- B. Test cable for continuity if cable is being installed for future expansion of the irrigation system.
- C. Replace defective wire, underground splices, or appurtenances. Repeat test until manufacturer's guidelines are met.

XI. Control System Grounding:

- A. Test for proper grounding of control system per manufacturer's recommendations. Test results must meet or exceed manufacturer's guidelines for acceptance.
- B. Replace defective wire, grounding rod, or appurtenances. Repeat the test until the manufacturer's guidelines are met.

XII. Mainline Pipe Tracing Wire

- A. Utilize the system grounding wire for mainline pipe tracing.
 - B. Test mainline grounding wire for continuity.
 - C. Testing shall be conducted in the presence of the Project Manager. Repair or replace defective tracing wire.
 - D. Testing shall be documented by the contractor and approved by the Project Manager.
- XIII. Testing Review
- A. Failure of initial testing review will require additional review. Payment of all cost, including travel expenses and site visits by City of Gillette Representative, for additional reviews that ;may be required due to non-compliance with the Construction Documents will be Contractor's responsibility.

1.07 CONSTRUCTION REVIEW:

The purpose of on-site reviews by the Project manager is to periodically observe the work in progress, the Contractor's interpretation of the construction documents, and to address question with regard to the installation.

- I. Scheduled reviews such as those for irrigation system layout or testing must be scheduled with the Project Manager as required by these specifications.
- II. Impromptu reviews may occur at any time during the project.
- III. A review will occur at the completion of the irrigation system installation and Project Record Drawing submittal.

1.08 COORDINATION AND SCHEDULING

- I. The irrigation construction schedule is to be provided at the Pre-Construction meeting depicting the dates the various stages of the project will start and when they will be completed.

1.09 GUARANTEE/WARRANTY AND REPLACEMENT:

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

- I. For a period of one year from the 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 defective item. Make repairs within seven days of notification from the Project Manager.
- II. Contract documents govern replacements identically as with new work. Make replacements at no additional cost to the contract price.
- III. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.

PART 2:MATERIALS

2.01 QUALITY: Use materials that are new and without flaws or defects of any type and which are the best of their class and kind.

2.02 SUBSTITUTIONS

- I. Alternative equipment must be approved by the Project Manager prior to bidding. The Contractor is responsible for making any changes to the design to accommodate alternative equipment.
- II. Pipe sizes referenced in the construction documents are minimum sizes, and may be increased at the option of the Contractor.

2.03 SLEEVING

- I. Sleeving material beneath pedestrian pavements shall be PVC schedule 40 pipe with solvent welded joints.
- II. Sleeving material beneath vehicular pavements shall be PVC schedule 80 pipe with solvent welded joints.
- III. Sleeving sizing: A minimum of twice the nominal diameter of solvent-welded pipe or wiring bundle, or as indicated on drawings. Sleeve diameter for gasketed pipe must accommodate outside diameter of joint-restraint casing spacers, refer to joint-restraint manufacturer's sizing recommendations.

2.04 PIPE AND FITTINGS

- I. Mainline Pipe and Fittings
 - A. 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.
 - B. Use schedule 40 PVC standard weight, all parts shall be injection molded of an improved PVC fitting compound. All threaded plastic fittings shall have injection molded threads. No cut threads will be accepted on PVC pipe and fittings. All tees and ells shall be manufactured in injection molds that are side gated. All threaded nipples shall be standard weight schedule 80 with molded threads.
 - C. Use rubber-gasketed pipe equipped with factory installed reinforced gaskets for mainline pipe with nominal diameter greater than or equal to 3-inches. Use Gasketed pipe joints conforming to "Laboratory Qualifying Tests" section of ASTM D3139. Use gasket material conforming to ASTM F477. Use Harco or approved equal rubber-gasketed deep bell ductile iron fittings conforming to ASTM A-536 and ASTM F-477. Use Lubricant approved by pipe manufacturer.
 - D. 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, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784. Use primer approved by the pipe manufacturer. Solvent cement to conform to ASTM Standard D2564.
 - E. Mainline pipe within sleeves: Use solvent weld pipe for mainline pipe with nominal diameter 4-inches and smaller installed within sleeves. Use pipe equipped with factory installed reinforced gaskets for mainline pipe with nominal diameter of 6-inches and larger installed within sleeves. Provide restrained casing spacers where gasketed joints occur within sleeve.
- II. Lateral Pipe and Fittings
 - A. 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 and integral belled end suitable for solvent welding.
 - B. 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.
 - C. Use solvent weld pipe for lateral pipe. Use Schedule 40, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784 for PVC pipe. Use primer approved by the pipe manufacture. Solvent cement to conform to ASTM Standard D2564, of a type approved by the pipe manufacturer.
- III. Inline Drip Tubing and Fittings
 - A. Drip Tubing
 1. Use UV resistant polyethylene drip tubing with integral pressure compensating drip emitters.
 2. Emitter spacing and flow as noted in drawings and installation details.

3. Use emitters that are pressure compensating from 15 to 60 PSI.
 4. Use tubing with outside diameter from 0.630" to 0.710", and inside diameter from 0.560" to 0.540".
 5. Use tubing stakes or landscape fabric staples to hold above-ground pipe in place.
 - a. Place stakes or staples 18" to 24" OC, or as needed to secure tubing.
- B. Blank Tubing
1. Use UV resistant polyethylene blank tubing for start connections between manifolds and drip tubing, and supply and exhaust manifolds, with flows less than three and one half (3.5) GPM.
 2. Use tubing with outside diameter from 0.630" to 0.710" and inside diameter from 0.560" to 0.540".
 3. Use tubing stakes or landscape fabric staples to hold above-ground pipe in place.
 - a. Place stakes or staples 18" to 24" OC, or as needed to secure tubing.
- C. Fittings
1. Use fittings manufactured from UV resistant material.
 2. Use Compression fittings for all tubing to tubing connections
 - a. Fittings shall accept tubing with outside diameters from 0.630" to 0.710".
 - b. Acceptable manufacture and models: Rain Bird Easy Fit Compression Fittings.
 3. Use Threaded by insert fittings for making connections from valves and/or PVC fittings to tubing.
 - a. Fittings shall accept tubing with outside diameters from 0.630" to 0.710".
 - b. Acceptable manufacture and models:
 - i. Rain Bird Easy Fit Compression Fittings
 - ii. Netafim 17mm Dripline Fittings
- IV. Specialized Pipe and Fittings
- A. Low Density Polyethylene Hose
 1. Use pipe specifically intended for use as a flexible swing joint.
 - a. Inside diameter, 0.490 ± 0.010 inch.
 - b. Wall thickness, 0.100 ± 0.010 inch.
 - c. Color, Black.
 2. Use spiral barbed fittings supplied by the same manufacturer as the hose.
 - B. Assemblies calling for flanged connections shall utilize stainless steel studs and nuts and rubber gaskets.
 - C. Assemblies calling for threaded pipe connections shall utilize PVC Schedule 80 and 40 threaded fittings and Rain Bird pre-manufactured swing-joint assemblies. Use PVC Schedule 80 nipples.
 - D. Joint sealant, use non-hardening, nontoxic pipe thread sealant formulated for use on threaded connections and approved by the pipe fitting and valve manufacturer. Where directed by valve manufactures, use threaded tape for threaded connections at valves and instead of thread paste.
 - E. Copper pipe, use Type "K" rigid pipe conforming to ASTM Standard B88. Use wrought copper or cast bronze fittings, soldered, flared mechanical, or treaded joint per installation details or local code. Use a 95 – percent tin and 5 – percent antimony solder.
- V. Ductile Iron Fittings
- A. Use Harco or approved equal rubber-gasketed deep bell ductile iron fittings for all changes in directions, at all service tees for remote control valves and quick coupling valves with mainline pipe with nominal diameter greater than or equal to 3-inches.
- VI. Joint Restrain Harness
- A. Provide joint restraint harness components as recommended by pipe and fitting manufacturer and in accordance with accepted industry practices. For joint restrains

on ductile iron pipe applications, use restraint components constructed of 60-42-10 ductile iron conforming to ASTM A536. For joint restraints on PVC pipe application, use restraint components constructed of 60-42-10 ductile iron conforming to ASTM A536-80 and ASTM F1674-96.

- B. Use bolts, nuts, retaining clamps, all-thread, or other joint restraint harness materials that are zinc plated or galvanized.
 - C. Use on pipe greater than or equal to 3-inch diameter or any diameter rubber gasketed pipe.
- VII. Thrust Blocks: If required for 3" and greater mainline
- A. Use 3,000 PSI concrete. Use commercially pre-mixed concrete unless written approval is provided by Project Manager prior to construction.
 - B. Use 2-mil plastic protective sheeting.
 - C. Use No. 4 Rebar.

2.05 MAINLINE COMPONENTS

- I. Backflow Prevention Device
 - A. As presented in the installation details.
 - B. This device shall protect against any Cross-Connection between the irrigation system and the public's potable water supply.
 - C. This device shall provide protection against both Back-siphon and Backpressure conditions
 - D. This device shall protect against High Hazard conditions.
 - E. This device shall be Testable.
 - F. The assembly shall be intended for use under continuous pressure applications
 - G. Acceptable Manufactures are, Feboc and Wilkins.
- II. Backflow Prevention Device Enclosures (If exterior mounted)
 - A. Enclosures shall be designed to protect the Backflow assemblies against vandalism and theft, and shall be lockable.
 - B. Enclosures shall be constructed with 1-1/4" Sch. 40 ASTM steel pipe end frames, 1" x 1" x 1/8" steel angle iron bases, and 1/2" #13 ga. diamond pattern flat rolled expanded steel top, side, and ends welded 4" o.c.
 - C. Enclosures shall have no sharp corners or edges.
 - D. Enclosures shall be Power Coated with a 1.5 to 2.0 mil thickness of polyester powder.
 - a. Green color.
 - E. Acceptable Manufactures are Guard Shack.
- III. Master Valve Assembly
 - A. As presented in the installation details.
 - B. Acceptable Manufactures are Bermad 410 Series normally open (unless otherwise specified).
- IV. Flow Sensor Assembly
 - A. As presented in the installation details.
 - B. Acceptable Manufactures are Rain Bird and Data Industrial.
- V. Isolation Gate Valve Assembly
 - A. As presented in the installation details.
 - B. Acceptable Manufactures are, American AVK, Clow, Kennedy, Mueller, Matco, Nibco, or Waterous.
- VI. Quick Coupling Valve Assembly
 - A. As presented in the installation details.
 - B. Acceptable Manufactures are Rain Bird.

2.06 SPRINKLER IRRIGATION COMPONENTS

- I. Remote control valves (RCV) Assembly for Sprinkler Laterals

- A. As presented in the installation details.
 - B. Use wire connectors and waterproofing sealant to join control wires and solenoid valves.
 - C. Use standard Christy I.D. tags with hot-stamped black letters on a yellow background.
 - D. Install a separate valve box over a 3-inch depth of ¾"-inch gravel for each assembly.
 - E. Provide PRS-D Pressure Regulating Modules at all spray and rotor sprinkler remote control valves.
- II. Sprinkler Assembly
 - A. As presented in the installation details.
- III. Sprinkler Pressure Test Kit
 - A. Provide one assembly per project.
 - 1. Assembly shall include one Rain Bird PHG and one Rain Bird Pitot Tube (part no. 41017), for use in pressure adjustment for spray and rotor sprinklers.

2.07 DRIP IRRIGATION COMPONENTS

- I. Remote Control Valve (RCV) assembly for Drip Laterals
 - A. As presented in drawings and installation details.
- II. Flush Valve Assembly
 - A. As presented in the installation details.

2.08 CONTROL SYSTEM COMPONENTS

- I. Satellite Controller Assembly: As presented in drawings and installation details. All incidental parts which are not specified herein and are necessary to complete the system shall be furnished and installed as though such parts were shown on plans or specified. All systems shall be in satisfactory operation at the time of completion.
- II. Basis of design product is Rainbird ESP-LXD with ET Manager cartridge.
 - A. Communication Path
 - 1. Each satellite and decoder shall be grounded by means that conform to the requirements of the National Electrical Code, current edition as adopted by the City, and the manufactures specifications. No solder connections will be allowed. Resistance to ground shall be no greater than 10 ohms.
 - B. Automatic Controller(s) and Related Equipment
 - 1. Pre-assembled and tested by a local authorized Toro Sentinel central control system representative, and as presented conceptually in the installation details.
 - 2. Acceptable manufacture, Toro Sprinkler Manufacturing Corp. Controller shall be installed per manufacturers specifications, and as specified herein.
 - C. Satellite Controller Assembly(s)
 - 1. Controller enclosure shall be provided by Rainbird Corp. or approved equal.
 - 2. The above described product shall be a NEMA 3R rain-proof enclosure as listed by Underwriter Laboratories, INC.
 - 3. Each satellite assembly shall have one (1) flow sensing assemblies for each point-of-connection, properly sized to monitor and react to excessive system flows.
 - 4. All components shall be properly and neatly wired to the appropriate terminal interface board. Bundle wires and tie with nylon zip-ties.
 - 5. The satellite assembly shall be covered by a five-year limited warranty. Warranty service shall be preformed in the field on the site where equipment is located.
 - D. Wire Markers
 - 1. Pre-numbered or labeled with indelible non-fading ink, made of permanent, non fading material.
 - E. Lightning protection

1. Provide one 12" x 36" x 0.0625 ground plate, one 5/8" x 10 foot copper clad UL listed grounding rod, 30 feet of #6 AWG bare copper grounding wire, and one CADWELD connector, and two 6-inch round valve boxes at each satellite controller group.

F. DECODERS

1. Modules for interfacing communication from controller to solenoid valves:
 - a. Description: Waterproof, pre assembled, addressable, programmable element, ranges from single station to multiple station controls.
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. Rain Bird Corporation.
 - b. Hunter Industries Incorporated.
 - c. Toro Company (The); Irrigation Division.
3. **Product will meet all requirements for interface per specific irrigation automatic controller needs; all products require pre-approval by Landscape Architect as well as potential manufacturer support and owner training in order to meet warranty requirements and proper use.**

III. Decoder Wire

- A. Wire for the decoder system shall be dual conductor solid core tin coated, soft drawn bare copper, meeting ASTM Spec. 33. PVC insulated insulation, with PE outer jacket, UL approved, underground wire for direct burial in ground. Wire shall be #12 AWG, unless recommended otherwise by manufacturer.
- B. Splices
 1. Use 3M 82-A series connectors.
- C. Conduit
 1. PVC Schedule 40.
- D. Warning tape
 1. Insert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. Three inches wide, colored red, and imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW"

IV. Grounding Cable

- A. Use #10 AWG bare copper wire to connect to grounding plate mounted near point of connection.

2.09 OTHER COMPONENTS

- I. Warning tape
 - A. plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. Three inches wide, colored red, and imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW"
- II. Tools and Spare Parts: Provide operating keys, servicing tools, spare parts and other items indicated in the General Notes of the Drawings.
- III. Other Materials: Provide 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.

PART 3: EXECUTION

3.01 INSPECTIONS AND REVIEWS

- I. Site Inspections
 - A. Verify construction site conditions and note irregularities affecting work of this section. Report irregularities to the Project Manager prior to beginning work.
 - B. Coordinate and provide testing of signal integrity between on-site satellite controller and the Central Control Computer as designated by Project Manager.
 - C. Beginning work of this section implies acceptance of existing conditions.
- II. Utility Locates (One Call 1-800-849-2476)
 - A. Arrange for and coordinate with local authorities the location of all underground utilities.
 - B. Repair and underground utilities damaged during construction. Make repairs at no additional cost to the contract price.

3.02 LAYOUT OF WORK

- I. Stake out the irrigation system. Items to be staked include: backflow device; control valves; sleeving; mainline and lateral pipe; drip line grids; drip line flush valves; air/vacuum relief valves; quick coupling valves; isolation valves; controller assembly; and sprinklers.
 - A. Irrigation System Layout Review: Irrigation system layout review will occur after the staking has been completed. Notify the Project Manager one week in advance of review. Modifications will be identified by the Project Manager at this review.
- II. Install all mainline pipe and mainline components inside of project property lines.

3.03 EXCAVATION, TRENCHING, AND BACKFILLING

- I. Excavate to permit the pipes to be laid at the intended elevations and to permit work space for installing connections and fittings.
- II. Minimum cover (distance from top of pipe or control wire to finish grade)
 - A. 24-inches over mainline pipe and over electrical conduit.
 - B. 28-inches over control wire and sensor cable.
 - C. 18-inches over lateral pipe to sprinklers.
- III. Maintain at least 15-foot clearance from the centerline of any tree.
- IV. Backfill only after lines have been reviewed and tested.
- V. Excavated material is generally satisfactory for backfill. Backfill shall be free from rubbish, vegetative matter and stones larger than 2-inches in maximum dimension. Frozen material will not be allowed. Remove material not suitable for backfill. Backfill placed next to pipe shall be free of sharp objects that may damage the pipe.
- VI. Backfill un-sleeved pipe in either of the following manners:
 - A. 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.
 - B. 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.
- VII. 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. Use of water for compaction around sleeves, "puddling", will not be permitted.
- VIII. Dress backfilled areas to original grade. Incorporate excess backfill into existing site grades.
- IX. Where utilities conflict with irrigation trenching and pipe work, contact the Project Manager for trench depth adjustments.

3.04 SLEEVING AND BORING

- I. Install sleeving at a depth that permits the encased pipe or wiring to remain at the specified burial depth.
- II. Extend sleeve ends six inches beyond the edge of the paved surface. Cover pipe ends and mark with stakes.
- III. Bore for sleeves under obstructions that cannot be removed. Employ equipment and methods designed for horizontal boring.

3.05 ASSEMBLING PIPE AND FITTINGS

- I. General
 - A. Keep pipe free from dirt and pipe scale. Cut pipe ends square and debur. Clean pipe ends.
 - B. Keep ends of assembled pipe capped. Remove caps only when necessary to continue assembly.
 - C. 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 pipe by pipe size are shown in the following table. All curvatures results from the bending of the pipe lengths. No deflection will be allowed at a pipe joint.

SIZE	RADIUS	OFFSET PER 20' LENGTH
1-1/2"	25'	7'-8"
2"	25'	7'-8"
2-1/2"	100'	1'-11"
3"	100'	1'-11"
4"	100'	1'-11"
6"	150'	1'-4"

- II. Mainline Pipe and Fittings
 - A. Use only strap-type friction wrenches for threaded plastic pipe.
 - B. PVC Rubber-Gasketed Pipe
 - 1. Use pipe lubricant. Join pipe in the manner recommended by manufacturer and in accordance with accepted industry practices.
 - C. PVC Solvent Pipe
 - 1. Use primer and solvent cement. Join pipe in a manner recommended by the manufacturer and in accordance with accepted industry practices.
 - 2. Cure for 30 minutes before handling and 24 hours before allowing water in pipe.
 - 3. Snake pipe from side to side within the trench.
 - D. Fittings
 - 1. The use of cross type fittings is not permitted.
 - 2. Ductile iron fittings shall not be struck with a metallic tool. Cushion blows with a wood block or similar shock absorber.
- III. Lateral Pipe and Fittings
 - A. Use only strap-type friction wrenches for threaded plastic pipe.
 - B. PVC Solvent Weld Pipe
 - 1. Use primer and solvent cement. Join pipe in the manner recommended by the manufacturer and in accordance with accepted industry practices.
 - 2. Cure for 30 minutes before handling and 24 hours before allowing water in the pipe.
 - 3. Snake pipe from side to side within the trench.
 - C. Fittings: The use of cross type fittings is not permitted.
- IV. Specialized Pipe and Fittings
 - A. Low Density Polyethylene Hose: Install per manufacturer's recommendations.

- B. Flanged connections: Install stainless steel studs and nuts and rubber gaskets per manufacture’s recommendations.
- C. PVC Threaded Connections
 - 1. Use only factory-formed threads. Field-cut threads are not permitted.
 - 2. Use only non-hardening, nontoxic thread sealant. Apply thread sealant in a manner recommended by component, pipe and sealant manufacturers and in accordance with accepted industry practices.
 - 3. When connection is plastic-to-metal, the plastic component shall have male threads and the metal component shall have female threads.
- D. Make metal-to-metal, threaded connection with non-hardening, nontoxic pipe sealant applied to the male threads only.
- E. Copper Pipe
 - 1. Use flux and solder. Join pipe in manner recommended by manufacturer and in accordance with local codes and accepted industry practices.
 - 2. Solder so that continuous bead show around the joint circumference.
- F. Thrust Blocks
 - 1. Use thrust blocks for fittings on pipe greater than or equal to 3-inch diameter, or any diameter of rubber gasketed pipe.
 - 2. Size, orient, and place cast-in-place concrete against undisturbed soil as shown on installation details.
 - 3. Wrap fittings or component with plastic to protect bolts, joint, gasket and fitting from concrete. Do not bury fitting or component in concrete.
 - 4. Commercially delivered concrete requires a 3,000 PSI mix.
 - 5. If pre-mix bags are used, mix per manufacture’s recommendations (maximum 1 gallon of water to 80-pound bag of pre-mix).
 - 6. Contractor is responsible for performing a slump test (minimum of 2-inches to a maximum of 4-inches) if requested by the Project Manager.
- G. Joint Restraint Harness
 - 1. Use on pipe 3-inch diameter or any diameter of rubber gasketed pipe. Use joint restraint harnesses on all service tees for remote control valves and quick coupling valves. Use a joint restraint harness wherever directional fittings or valves are not positively restrained by flanged fittings, threaded fittings, and/or thrust blocks.
 - 2. Use a joint restraint harness with transition fittings between metal and PVC pipe, where weak trench banks do not allow use of thrust blocks, or where extra support is required to retain directional fitting or joint.

3.06 INSTALLATION OF MAINLINE COMPONENTS

- I. Winterization Assembly: Provide per installation details where indicated on drawings. Brand “WA” on valve box lid in 2-inch high letters.
- II. Master valve Assembly: Provide per installation details where indicated on the drawings. Brand “MCV” on valve box lid in 2-inch high letters.
- III. Flow Sensor Assembly: Provide per installation details where indicated on the drawings. Brand “FS” on valve box lid in 2-inch high letters.
- IV. Isolation Gate Valve Assembly: Provide per installation details where indicated on the drawings. Install at least 12-inches from and align with adjacent walls or edges of paved areas. Brand “GV” on valve box lid in 2-inch high letters.
- V. Quick Coupling Valve Assembly: Provide per installation details where indicated on drawings. Brand “QC” on valve box lid in 2-inch high letters.

3.07 INSTALLATION OF SPRINKLER IRRIGATION COMPONENTS

- I. Remote Control Valve (RCV) Assembly for Sprinkler Laterals
 - A. Flush mainline before installation of RCV Assembly.

- B. Provide per installation details where indicated on drawings. Use wire connector and waterproof to connect control wires to remote control valve wires. Use 3M DBY-6 or DBR-6 connectors and sealant per manufacturer's recommendations.
 - C. Provide only one RCV to a valve box. Locate valve box at least 12-inches from and align with nearby walls or edges of paved areas. Group RCV assemblies together where practical. Arrange grouped valve boxes in rectangular patterns. Allow at least 12-inches between valve boxes.
 - D. Adjust RCV assembly to regulate downstream operating pressure.
 - E. Attach ID tag with controller station number on control wiring.
 - F. Brand controller letter and station number on valve box lid in 2-inch high letters.
- II. Sprinkler Assembly
- A. Flush lateral pipe before installing sprinkler assembly.
 - B. Provide per installation details at location shown on drawings.
 - C. Locate rotary sprinklers 6-inches from adjacent walls, fences, or edges of paved areas.
 - D. Locate spray sprinklers 3-inches from adjacent walls, fences, or edges of paved areas.
 - E. Install sprinklers perpendicular to finish grade.
 - F. Supply appropriate nozzle and/or adjust arc of coverage and/or radius of throw of each sprinkler for best performance and uniform coverage.
- III. Sprinkler Pressure Test Kit
- A. Use a pitot tube and pressure gauge at the worst-case rotor sprinkler assembly, from the respective remote control valve. Adjust PRS-Dial at each rotor remote control valve, to provide the design operating pressure at the worst-case rotor sprinkler head. Typically the worst-case sprinkler is the sprinkler furthest from the remote control valve. Complete pressure adjustments for every rotor remote control valve.
 - B. Using pressure gauge and necessary fittings, place pressure gauge on worst-case spray sprinkler, from the respective remote control valve. Adjust PRS-dial at each spray remote control valve to provide an operation pressure of 30 PSI at the worst-case spray sprinkler head. Typically the worst-case sprinkler is the sprinkler furthest from the remote control valve. Complete pressure adjustment for each spray remote control valve.
 - C. Turn over pitot tube and pressure gauge to the Project Manager at completion of construction.

3.08 INSTALLATION OF DRIP IRRIGATION COMPONENTS

- I. Remote Control Valve (RCV) Assembly for Drip Laterals
 - A. Flush mainline pipe before installing RCV assembly.
 - B. Provide per installation details where indicated on drawings. Use wire connector and waterproof to connect control wires to remote control valve wires. Use 3M DBY-6 or DBR-6 connectors and sealant per manufacturer's recommendations.
 - C. Provide only one RCV to a valve box. Locate valve box at least 12-inches from and align with nearby walls or edges of paved areas. Group RCV assemblies together where practical. Arrange grouped valve boxes in rectangular patterns. Allow at least 12-inches between valve boxes.
- II. Inline Drip Tubing: Install inline drip tubing components in strict accordance with tubing manufacturer's details, guidelines, and recommendations.
- III. Flush Valve Assembly: Provide at end of each dripper line grid as show and directed on the drawing and installation details. Install at least 12-inches from and align with adjacent walls or edges of paved areas. Brand "FV" on valve box lid in 2-inch high letters.

3.09 INSTALLATION OF CONTROL SYSTEM COMPONENTS

- I. Satellite Control Assemblies

- A. The location of the Satellite Controller Assemblies as depicted on the drawings is approximate; The Project Manager will determine the exact site location during sprinkler layout review.
 - B. Assemble satellite control assembly, sensors, and appurtenance in satellite enclosure per authorized manufacturer representative recommendation and shop drawings. Provide pre-fabrication and testing of controller assembly by authorized Toro Sentinel distributor representative prior to installation in field. Provide installation observation and wire connections in field by manufacturer's personnel or trained distributor personnel.
 - C. Provide combination switch/GFCI outlet in accordance with local codes inside satellite controller assembly enclosure.
 - D. Provide electrical service connection for Satellite Controller Assemblies under direction and observation of manufactures' personnel or trained distributor personnel. Utilize existing electrical source. Provide primary surge protection arrestors on incoming power lines in accordance with control system manufacturer recommendations.
 - E. Lightning protection: Drive grounding rod into soil its full length. Space rod and grounding plate 20 feet apart in a straight line away from controller. Connect #6 AWG copper grounding wire to rod from plate using CADWELD connection. Install 6-inch round valve box over each CADWELD connection and grounding plate connection. Connection of grounding wire to the satellite must be per satellite manufacturer or distributor's recommendations.
 - F. 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.
 - G. Connect control wires to the corresponding controller terminal.
- II. Power Wire
- A. Install with a minimum number of field splices. If a power wire must be spliced, make spice 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.
 - B. All power wire shall be laid in trenches. The use of vibratory plow is not permitted.
 - C. Green wire shall be used as the ground wire from power source to all satellites.
 - D. Carefully backfill around power wire to avoid damage to wire insulation or wire connectors.
 - E. Unless noted on plans, install wire parallel with mainline pipe. Install wire a minimum of 2-inches below top of PVC mainline pie.
 - F. Encase wire not installed with PVC pipe, in electrical conduit with a continuous run of warning tape placed in the backfill, 6-inches above the wiring.
- III. Decoder Wire
- A. Wire for the decoder system shall be dual conductor solid core tin coated, soft drawn bare copper, meeting ASTM Spec. 33. PVC insulated insulation, with PE outer jacket, UL approved, underground wire for direct burial in ground. Wire shall be #12 AWG, unless recommended otherwise by manufacturer.
 - B. Provide a 24-inch 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.
 - C. Install common ground wire and one control wire for each remote control valve.
 - D. If a control wire must be spiced, make spice with wire connectors and waterproof sealant, installed per the manufacturer's instructions. Locate splice in a valve box that contains an irrigation valve assembly, or in a separate 12-inch standard valve box. Use same procedure for connection to valves as for in-line splices. Utilize DBY-6 or DBR-6 splices.

- E. Protect wire not installed with PVC mainline pipe with a continuous run of warning tape placed in the backfill six inches above the wiring.
- F. Make all decoder wire connections according to manufacturer's recommendations.
- G. Conduct instructional training with owner's representative on performance of decoder system. Cover aspects of maintaining, operating, and possible failures.

IV. Instrumentation

- A. Provide sensors as indicated on drawings and installation details, and in accordance with manufacturer's recommendations.
- B. Provide electrical connections between central control system hardware and sensors under direction and observation of manufacturer's personnel or trained distributor personnel.

3.10 INSTALLATION OF OTHER COMPONENTS

- I. Tools and Spare Parts: Prior to the Review at completion of construction, supply to the Owner operating keys, servicing tools, spare parts, and any other items indicated in the General Notes on the drawings.
- II. 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 PROJECT RECORD DRAWINGS

- I. The Contractor is responsible for documenting changes to the design. 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.
- II. Record pipe and wiring network alterations. Record work that is installed differently than show 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.
- III. Prior to construction completion, obtain from the Project Manager an AutoCAD data file for this project. Using CAD, duplicate information contained on the project drawings maintained on site. Label each sheet "Record Drawings".
- IV. Turn over the "Record Drawings" to the Project Manager. Completion of the Record Drawings will be a prerequisite for the Review at the completion of the irrigation system installation.

3.12 WINTERIZATION AND SPRING START-UP

- I. Winterize the irrigation system in the fall after the installation, and start-up the irrigation system the following spring. Repair any damage caused in improper winterization at no additional cost to the Owner. Coordinate the winterization and start-up with the Project Manager.

3.13 MAINTENANCE

- I. Upon completion of construction and Review by the Project Manager, maintain irrigation system for a duration of 30 calendar days. Make periodic examinations and adjustments to irrigation system components so as to achieve the most desirable application of water.
- II. 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 after the landscape maintenance operation.

3.14 CLEANUP

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

END OF SECTION 02810