

TABLE OF CONTENTS
PART II – CONSTRUCTION MATERIALS AND METHODS
SECTION 40

IRRIGATION SYSTEMS

<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
40.1	GENERAL	40.1
	40.1.1 References	40.1
	40.1.2 Quality Assurance	40.2
	40.1.3 Submittals	40.3
40.2	MATERIALS	40.4
40.3	CONSTRUCTION PRACTICES	40.8
	40.3.1 Delivery, Storage, and Handling	40.8
	40.3.2 Job Site Conditions	40.8
	40.3.3 Landscape Plan Review and Coordination	40.9
	40.3.4 Static Pressure Verification	40.10
	40.3.5 Inspection	40.10
	40.3.6 Preparation	40.10
	40.3.7 Installation	40.12
	40.3.8 Field Quality Control	40.16
	40.3.9 Adjusting	40.17
	40.3.10 Cleaning	40.18
40.4	WARRANTY/GUARANTY	40.18
	40.4.1 Maintenance	40.18

PART II - CONSTRUCTION MATERIALS AND METHODS
SECTION 40

IRRIGATION SYSTEMS

40.1 GENERAL

These Specifications shall apply to all new construction or to all repair work on existing irrigation systems within the City of Arvada. Contractors that are working on projects for developers, project owners or other agencies that are obligated to complete work on a city-owned or city-controlled project will comply with all the following specifications for Irrigation Systems. If a developer/owner is responsible for installation of an irrigation system that will be privately owned, controlled and maintained, the following specifications apply to their installation through the vacuum breaker. Downstream of the vacuum breaker, the developer/owner and their contractor are not controlled by these specifications, unless the developer/owner chooses, by reference, to incorporate all or portions of these specifications in their project.

Work of this Section generally includes provisions for the installation of an underground irrigation system including the following:

- A. Static pressure verification and coordination of irrigation system installation with landscape material installation.
- B. Trenching, refilling and compacting trenches.
- C. Complete irrigation system including but not limited to piping, valves, fittings, heads, central control system, controllers and wiring, and final adjustments to insure complete coverage.
- D. Water connections.
- E. Replacement of unsatisfactory materials.
- F. Clean-up, inspections, and approval.
- G. Tests.

40.1.1 References

- A. Perform work in accordance with requirements of Special Conditions of the Contract as well as provisions of all applicable laws, codes, ordinances, rules, and regulations.
- B. All work shall conform to the requirements of reference information listed below except where more stringent requirements are specified in Contract Documents or Special Conditions.
 - 1. American Society for Testing and Materials (ASTM) - Specifications and Test Methods specifically referenced in this Section.
 - 2. Underwriters Laboratories (UL) - UL Wires and Cables.

Quality Assurance

- A. Installer Qualifications - Installer shall have had experience and demonstrated ability in the installation of irrigation system(s) of specific type(s) in a professional, orderly, and responsible manner in accordance with recognized standards of workmanship.
1. List five (5) projects completed in the last two (2) years of similar complexity to this Project. Description of projects shall include:
 - a. Name and start/completion dates for each project.
 - b. Location: address including city.
 - c. Contact name/project manager phone number, FAX number and/or e-mail address.
 - d. Brief description of work and project budget, including design, if available.
- B. Special Requirements:
1. Work involving plumbing for installation of copper piping, backflow preventer(s) and related work shall be executed by plumber(s) licensed to work in the City of Arvada and bonded. The contractor will be required to secure a permit at least 48 hours prior to start of installation.
 2. Tolerances - Specified depths of mains and laterals and pitch of pipes are minimums. Any settlement of trenches below finished grade is cause for removal of finished grade treatment, refilling, compaction, and repair of finished grade treatment.
 3. Coordination with Other contractors – The irrigation contractor must protect work in progress by other contractors and coordinate work with other contractors or subcontractors, as directed by the project manager, to avoid interruptions or delays.
 4. Damage To Other Improvements - For all city projects, the contractor shall replace or repair damage to grading, soil preparation, seeding, sodding, or planting done during work associated with installation of irrigation system at no additional cost to City, unless otherwise specified in Contract documents.
 5. All backflow preventer(s) will be tested and approved by a Colorado State-certified backflow tester upon installation. Reports will be submitted to the Parks Irrigation Supervisor for city approval within 5 calendar days after certification testing and prior to final city acceptance of a city project.
 6. For all City projects, the contractor will install each backflow device within a "Guard Shack" enclosure that satisfies the project specifications and inspection by the Parks Irrigation Supervisor.
- C. Pre-Construction Conference – For all city projects, the contractor shall schedule and conduct a conference to review, in detail, quality control and construction requirements for equipment, materials, and systems intended for execution of the work. The contractor will schedule this conference not less than 10 days prior to

commencement of on-site construction. The contractor will notify all subcontractors, suppliers, and city representatives that will participate in the construction no later than 7 days prior to the conference. As a minimum, the contractor shall notify the project manager, the Contractor's Superintendent or site supervisor, the irrigation installer, the Parks Maintenance Supervisor, and the Parks Irrigation Supervisor. The contractor will record and distribute minutes from the conference to all parties in attendance within five calendar days

40.1.3 Submittals

For all city projects, the contractor will prepare and make submittals to the project manager the following information:

- A. Materials List – The contractor will submit a complete materials list indicating manufacturer, model number, and description of all materials and equipment to be used. If the contractor proposes to change or clarify any of the project specifications for materials, the contractor needs to show appropriate dimensions and adequate detail to accurately portray the contractor's intent, all of which is subject to written city approval.
- B. Record Drawings (As-Built):
 - 1. At onset of any city irrigation installation, the contractor will secure digital files of original irrigation design from the Parks and Urban Design Division (at the Pre-Construction Conference,). The contractor will keep available a set of construction plans at the project site. At the end of every day, revise prints for work accomplished that day in red ink. Hard copy as-built plans will be brought up-to-date at the close of the working day every Friday. The Parks Irrigation Supervisor or their representative will review and approve these weekly plan changes each Monday morning during active construction at the project site. The project manager will require that weekly plan changes are approved by the Parks Irrigation Supervisor prior to the release of monthly and final payments to the Contractor. Plan changes will include zoning changes and changes to non-pressure piping that must be approved by the project manager, on weekly as-built drawings and ultimately onto the final set of as-built drawings. Upon completion of the construction and prior to final project acceptance , the Contractor will submit a final set of as-built files on a CD to the project manager with dimensions for all changes to the construction plans, from two or more permanent points of reference (building corners, sidewalk, road intersections or permanent structures), In addition, the contractor will provide 2 or more dimensions that will locate the following improvements on-site:
 - a. Contractor connections to city water mains and wherever an existing irrigation water main or lateral line is extended.
 - b. All sprinkler control valves.
 - c. All quick coupling valves.
 - d. All drain valves.
 - e. Control wire routing if not with pressure mainline.
 - f. All gate and isolation valves.

- g. Control wire splices
 - h. Flow sensors (i.e., A-ROD Valves)
2. The project manager will not approve the final pay request if the as-built drawings are not submitted nor are not accurate based on final city field inspection. The Parks Irrigation Supervisor or their representative will verify weekly that as-builts are accurate and at final inspection.
- C. Operation Instructions – The contractor will submit three (3) sets of written operating instructions for each city project, including winterization procedures and system start-up. Furthermore, the contractor will coordinate controller operations for the benefit of the new and/or existing landscape with direction from the city Parks Manager or their representative.

Controller Charts:

1. The contractor will prepare irrigation zone controller charts once the Parks Irrigation Supervisor has reviewed and approved all record (As-built) drawings.
2. The contractor will provide one controller chart for each automatic controller installed.
 - a. The Chart may be a reproduction of a record (As-built) drawing if it is a scaled drawing that fits on the inside of the controller box door. If photo reduction prints are necessary to make the image fit on the door of the controller box, the contractor will maximize the size of the reduction for optimum legibility.
 - b. The Chart may be a print of the actual "as-built" system, showing each zone and related zone number connected to that controller.
3. Identify the coverage area for each remote control valve (also zone or station,) using distinctly different graphics for each valve/zone/station.
4. Following review and acceptance of each chart by the Parks Irrigation Supervisor, the contractor will hermetically seal each chart between two layers of 20-mm thick plastic sheet.

40.2 MATERIALS

- A. General Piping: No Galvanized pipe will be allowed on any irrigation system, unless specifically approved in the project specifications.
1. Pressure Supply Lines - Class 200 PVC BE (1" - 2 1/2"), Class 200 PVC RT (3" through 10").
 2. Non-pressure Lines - Class 200 PVC BE.
 3. PVC Sleeving – Class 200 PVC.

B. Plastic Pipe and Fittings:

1. Identification Markings:

a. Identify all pipe with following indelible markings:

- 1) Manufacturer's name.
- 2) Nominal pipe size.
- 3) Schedule of class.
- 4) Pressure rating.
- 5) NSF (National Sanitation Foundation) seal of approval.
- 6) Date of extrusion.

2. Solvent Weld Pipe - Manufactured from virgin polyvinyl chloride (PVC) compound in accordance with ASTM D2241 and ASTM D1784; cell classification 12454-B, Type 1, Grade 1.

a. Fittings - Standard Wright, Schedule 40, injection molded PVC; complying with ASTM D1784 and D2466, cell classification 12454-B.

- 1) Threads - Injection molded type (where required).
- 2) Tees and ells - Side gated.

b. Threaded Nipples - ASTM D2464, Schedule 80 with molded threads.

c. Joint Cement and Primer - Type as recommended by manufacturer of pipe and fittings. Only Weldon P-70 Primer and Weldon 711 Gray Glue or Weldon 725 Wet & Dry Glue will be allowed.

3. Gasketed End Pipe - Manufactured from virgin Polyvinyl Chloride compound in accordance with ASTM D2241 and ASTM D1784; cell classification 1254-B, Type 1, Grade 1.

a. Fittings and Services Tees (3" and 4") - Ductile iron, grade 70-55-05 in accordance with ASTM A-536. Fittings shall have deep bell push-on joints with gaskets meeting ASTM F-477. Unless otherwise indicated in the project specifications, all fittings will have pipe restraints and thrust blocks. 6" and larger pipe will have mechanical joint fitting and be installed per City of Arvada Engineering Standards Sections 30.2 and 30.3.

b. Gaskets - Factory installed in pipe and fittings, having a metal or plastic support within gasket or a plastic retainer ring for gasket.

c. Lubricant - As recommended by manufacturer of pipe fittings.

- d. All gasketed fittings will have Leemco Joint Restraints or approved equal. Leemco Joint Restraints will be attached per manufacturer's installation guide.

C. Gate Valves and Isolation Valves:

- 1. Gate Valves and Isolation Valves for 3/4 inch through 2 Inch Pipe – a “Ford B-44 Curbstop Ball Valve.”
- 2. Gate Valves and Isolation Valves for 2 ½ Inch Pipe - Brass construction; solid wedge, IPS threads, and non-rising stem with **square operating nut**.
- 3. Gate Valves and Isolation Valves for 3 Inch and Larger Pipe - Iron body, brass or bronze mounted AWWA gate valves with a clear waterway equal to full nominal diameter of valve, mechanical joint-type only. Valves shall be able to withstand a continuous working pressure of 200 psi and be equipped with a **square operating nut** and resilient wedge seat.

D. Quick Coupling Valves - Brass two-piece body designed for working pressure of 150 PSI; operable with quick coupler. Equip quick coupler with locking rubber cover. Key size and type as shown on plans and specifications for each project. (Rainbird 44 R.L.C. / 1-inch rubber locking cover or approved equal.)

E. Valve Boxes: Required with installation of the following-

- 1. Gate Valves, Isolation Valves, Quick Coupling Valves, Drain Valves and Wire Stub Box Carson/Brooks #910-10 box, or equal, with ID branded on lid.
- 2. 3/4 inch through 2 inch Control Valves (which includes a true union ball valve in the same box - Carson Brooks #1220-12 Jumbo box with valve # branded on lid that corresponds to the valve number identified for the same zone on the controller chart..
- 3. 3 inch and larger control valves will have the true union ball valve in a separate Carson 1220-12 Jumbo Valve Box. Each control valve will be in a separate Carson 1220-12 Jumbo Valve Box with valve # branded on lid that corresponds to the valve number identified for the same zone on the controller chart.

F. Electrical Control Wiring:

- 1. Low Voltage:
 - a. Electrical Control Wire - AWG UFUL approved No. 14 direct burial copper wire.
 - b. Electrical Common Wire - AWG UFUL approved No. 12 direct burial copper wire.
 - c. Wire Colors:
 - 1) Control Wires - Red.

- 2) Common Wires - White.
 - 3) Master Valve Wires – Blue (two wires going to each master valve)
 - 4) Spare Control Wires - Black.
 - 5) Spare Common Wires - Yellow.
 - 6) Flow Wire – Purple (two flow wires to each flow unit)
 - 7) Tracer Wire – Green AWG UFUL No.12 direct burial copper wire
- d. If multiple controllers are utilized, and wire paths of different controllers cross each other, both common and control wires from each controller shall be different colors approved by Parks Irrigation Supervisor.
 - e. Control and Tracer Wire connections and splices shall be made with 3M DBY or approved similar dry splice method in an approved splice box, such as a Carson #910-10.
2. High Voltage - Type required by local codes and ordinances, of proper size to accommodate needs of equipment serviced.
- G. Automatic Controller – For all city projects, an electric controller (or “clock”) will be supplied, installed and operated by the Contractor during construction and until any contract-related turf/landscape is established and approved by the city. Upon completion and city acceptance of the project, the Contractor will remove the installed electric controller and install the city’s Motorola controller, unless otherwise specified. The Motorola controller will be purchased by the City; a cost for which each developer will reimburse to the city as a condition of approval for the irrigation system or as otherwise approved in a Development Agreement between the city and the developer.
- H. Electric Control Valves - Size and type shown on Drawings having manual flow adjustment and manual bleed nut. (Rainbird EFB-CP Series or approved equal for clean water systems and Rainbird 300 BPES or approved equal.) For all control valves, the contractor will include a true-union ball valve, the same size as the control valve, installed on the inlet side of the valve (see details or install per manufacturer’s recommendations.)
- I. Sprinkler Heads - As indicated on Drawings. The Contractor will use fabricated riser units in accordance with details, or as otherwise specified, with riser nipples of same size as the riser opening in the sprinkler body. (Rainbird or approved equal.) For all pop-up spray heads, the contractor will use Rain Bird M.P.R. plastic nozzle **NO VAN NOZZLES ALLOWED, NO MARLEX FITTINGS ALLOWED.**
- J. Lateral Tracer Wire – One # 12 UF copper tracer wire in the same trench with all lateral lines running continuously from valve to end of lateral line. Coil an additional 12” at all bends and additional 24” in valve box.

40.3 CONSTRUCTION PRACTICES

40.3.1 Delivery, Storage, and Handling

The contractor will deliver, unload, store and handle materials, packaging, bundling and products in dry or weatherproof condition to prevent damage, breakage, deterioration, intrusion, ignition, and vandalism. All materials will be delivered in original unopened packaging containers that prominently display manufacturer's name, volume, quantity, contents, instructions, and conformance to local, state, and federal law, codes and regulations. For the contractor to receive credit for materials on site, the Parks Irrigation Supervisor or designated City representative will verify quantities on site, to the extent that they are related to the city's project, and satisfy the previous conditions. Upon inspection by city representatives (at any time during the construction process,) the contractor will remove and replace cracked, broken, or contaminated items or elements prematurely exposed to moisture, inclement weather, snow, ice, temperature extremes, fire, or jobsite damage.

Handling of PVC Pipe – The contractor will exercise care in handling, loading and storing PVC pipe. All PVC pipe shall be transported in a vehicle with adequate length for the entire length of pipe to lie flat with adequate support to eliminate any bending or concentrated external loads that cause pipe wall deflection. All pipe sections that have been dented or damaged shall be discarded, and if installed in that condition, shall be removed and replaced with new piping. The Parks Irrigation Supervisor or designated representative will inspect delivery to site.

40.3.2 Job Site Conditions

A. Protection of Property: For all city projects, the contractor will comply with the following:

1. Preserve and protect all trees, plants, monuments, structures, and paved areas from damage due to work of this Section. In the event damage does occur, all damage to inanimate items shall be completely repaired or replaced to satisfaction of the project manager or Park Manager, and all injury to living plants shall be repaired by the Contractor to the satisfaction of the Parks Forestry Supervisor. All costs of such repairs shall be charged to and paid by the Contractor.
2. Protect buildings, walks, walls, and other property from damage. Where the Contractor leaves open ditches or trenches within 10' feet of a trail edge, the Contractor will provide safety fencing 5' from trail edge that consists of tee-posts and orange plastic fabric a minimum of 30 inches high. Damage caused to asphalt, concrete, or other building material surfaces shall be repaired or replaced by Contractor at no cost to City. Restore disturbed areas (turf, groundcover and other landscape surfaces) to condition of the project prior to construction and to the satisfaction of the project manager or Parks Manager.

B. Existing Trees:

1. All trenching or other work under the drip line of any and all evergreens or deciduous trees shall be avoided by trenching around the drip line or done by hand or bored under the root zone so as to prevent damage to root zone, limbs or branches.

2. Where it is necessary to excavate within the drip line of existing trees, the contractor will use all possible care to avoid injury to tree trunks, limbs and roots. Excavation, in areas where 2 inch and larger roots occur, shall be done by hand. Where roots 2 inches or larger in diameter are uncovered by the excavation, they shall be heavily wrapped with burlap and watered to prevent scarring or excessive drying. Where a trencher is operated close to trees uncovering roots smaller than 2 inches in diameter, roots exposed in the trench adjacent to tree shall be hand trimmed, making clean cuts through roots. Trenches adjacent to trees shall be refilled and watered within 24 hours, and when this is not possible, the side of the trench adjacent to the tree shall be kept shaded with moistened burlap or canvas.

C. Protection and Repair of Underground Lines:

1. Request utility company "Locates" to stake exact locations (including depth) of all underground electric, gas, cable TV and telephone lines. The Contractor will undertake whatever precautions are necessary to protect these underground (and all overhead) lines from damage. If damage does occur, the related Utility Company shall repair all damage. The Contractor shall pay all costs of such repairs related to damage by the Contractor unless other arrangements have been made to the satisfaction of the city.
2. Request, in writing, through the project manager, the location of all City utilities and existing underground irrigation system (e.g., electrical service to outside lighting) before proceeding with excavation. If, after this request and related city marking or staking, the contractor damages city utilities that were not indicated on-site by the city, the City shall repair them at no cost to Contractor. If the Contractor damages utilities that are staked or otherwise located, they shall be repaired by the City at the Contractor's expense or by the contractor to the satisfaction of the City Division responsible for the inspection and project manager, unless other arrangements have been made.

- D. Replacement of Paving and Curbs - Where lines cross under existing roadways, paths, curbing, etc., the contractor will bore under these structures, install sleeving and pipe consistent with city specifications and avoid damage to existing structures.

40.3.3 Landscape Plan Review and Coordination

Contractor will be held responsible for coordination between landscape and irrigation system installation. If the Contractor determines that a conflict exists between landscape and irrigation plans, the Contractor, prior to initiating any construction, will communicate the problem to the project manager who will coordinate redesign to mitigate or resolve the conflict. If, during construction, the Contractor identifies a conflict between the landscape and irrigation design plans and communicates the conflict to the project manager, who will work out a design solution that best serves the city's intent for the project. Depending on the solution and if the contractor had the necessary information to identify the problem prior to construction, the irrigation contractor may be required to relocate irrigation equipment, at the Contractor's expense.

40.3.4 Static Pressure Verification

The Contractor shall field verify the static pressure available at the project site, prior to

commencing work or ordering irrigation materials, and submit findings, in writing, to the project manager and the Parks Irrigation Supervisor. If the Contractor fails to verify static water pressure prior to commencing work or ordering irrigation materials, the Contractor shall assume responsibility for all costs required to make the irrigation system operational and the costs required to replace any landscape materials damaged by irrigation system problems. Costs covered by the irrigation contractor will include: equipment, labor and material costs for removing and replacing any dead plant materials and the cost of the materials necessary for replanting, reseeding or resodding turf areas that are dead. Repairing damage to landscape areas may, at the discretion of the project manager, include an agreement with the contractor to operate and maintain the irrigation, landscape and turf until the damaged condition is recovered to a condition that complies with the project specifications to the satisfaction of the project manager.

40.3.5 Inspection

The project manager and Parks Maintenance representatives will examine areas and conditions under which work this Section is to be performed. The Contractor will not proceed with work until unsatisfactory conditions have been corrected. Grading operations, with the exception of final grading, shall be completed and approved by the project manager and Parks Maintenance representatives before staking or installation of any irrigation system begins.

40.3.6 Preparation

A. Staking shall occur as follows:

1. The Contractor will mark, with water base marking paint, the intended routing of the main pressure supply line and flag heads for all zones. The Contractor will contact the project manager and the Parks Irrigation Supervisor 48 hours before this work will be completed and request an inspection of the staking based on the design plans with the Contractor's recommended site adjustments. The Parks Irrigation Supervisor and the Parks Maintenance staff review staking and recommend changes that the contractor may choose to make or not. Whether the contractor chooses to make the changes or not, the Contractor is ultimately responsible for resolving coverage problems due to the placement of irrigation heads.
2. If a Project has significant topography, freeform planting beds, or other amenities, which could require changes to the layout of irrigation equipment from the approved design plans, the Contractor will, as deemed necessary by the Parks Irrigation Supervisor, not install irrigation equipment in these areas until the Parks Irrigation Supervisor has reviewed and approved staking by the Contractor for equipment positions that will more effectively irrigate the intended areas.

B. The Contractor will install sleeving under curbs, gutters, paving and pavers, trails and concrete sidewalks, prior to installation of these structures and surfaces, wherever piping and wiring are intended on the irrigation plans. The contractor will compact backfill around sleeves to 95% Modified Proctor Density within 2% of optimum moisture content in accordance with ASTM D1557. Compaction shall be verified by the project manager or the Parks Maintenance representative.

C. Trenching - Trench excavation shall follow, as much as possible, the intended layout shown on irrigation plans. The contractor will dig trenches straight and vertical that support pipe continuously on the trench bottom. The contractor will

ensure that the trench bottom is an open, level surface cleared of all rock and other inorganic and organic debris.

1. Clearances:
 - a. Piping 3" I.D. and Larger – The contractor will ensure that trenches are sufficient width (14 inches minimum) to properly assemble and position pipe in trench prior to installation of the pipe and fittings. The Contractor will also ensure that the clearance for piping 3 inches or larger is a minimum of 5 inches horizontally on both sides of the pipe.
 - b. Piping Smaller than 3 Inches – The contractor will ensure that trenches are a minimum of 7 inches wide for all pipe smaller than 3" I.D. prior to installation of the pipe and fittings.
 - c. Line Clearance – The contractor will provide not less than 6 inches of horizontal clearance between each irrigation line and not less than 5 feet of horizontal clearance between irrigation lines and underground utilities, located within the project. No vertical stacking of irrigation pipe is allowed on any new irrigation installation project and no vertical stacking of irrigation pipe is permitted around existing irrigation pipe unless written approval is given by Parks Irrigation Supervisor.
 - d. These requirements will be verified by the Parks Irrigation Supervisor.
2. Pipe and Wire Depth: The contractor will ensure the proper depth for each of the following pipe classifications intended for the project:
 - a. Pressure Supply Mainline - 24 inches from top of pipe to finished grade.
 - b. Pressure Supply Sub-mainline - 24 inches from top of pipe to finished grade.
 - c. PVC Sleeving – Sleeves will be set at the depth required for each irrigation pipe. Pipes with different depth requirements will be placed in separate sleeves at the required depths below finished grade.
 - d. Non-pressure Piping (for gear-driven and rotor heads) - 18 inches from top of pipe to finished grade.
 - e. Non-pressure Piping (pop-up spray heads) - 12 inches from top of pipe to finished grade.
 - f. Control Wiring – The Contractor will position wire along side pressure supply mainline or sub-mainline, where possible. If wire is not located with mainline, the Contractor will position it along side non-pressure piping. These requirements will be verified by the Parks Irrigation Supervisor.
3. Boring will be permitted only where pipe must pass under obstruction(s) which cannot be removed, such as tree root zones, pavements, etc. In

backfilling bore, final density of backfill shall match that of surrounding soil. It is acceptable to use sleeves of suitable diameter installed first by jacking or boring, and pipe laid through sleeves. Observe same precautions as though pipe were installed in open trench. **No Tunneling will be allowed.**

40.3.7 Installation

The Contractor will locate equipment in positions indicated on approved irrigation plans as much as possible. The Parks Irrigation Supervisor and/or the project manager shall review and approve deviations prior to installation.

- A. PVC Piping - Snake pipe in trench as much as possible to allow for expansion and contraction. Do not install pipe when air temperature is below 40 degrees F. Place manual drain valves at low points and dead ends of pressure supply piping to insure complete drainage of system as required. When pipe installation is not in progress, or at end of each day, the Contractor will close pipe ends with tight plug or cap. The Contractor will install PVC Pipe in accordance with the manufacturer's recommended specifications.
1. Solvent Weld PVC Pipe – The Contractor will lay pipe and make all plastic to plastic joints in accordance with manufacturer's recommendations.
 2. Gasketed End Pipes:
 - a. The Contractor will lay pipe and make pipe-to-fittings or pipe-to-pipe joints following OR70 recommendations (Johns-Manville Guide for Installation of Ring-Tite Pipe) or follow the pipe manufacturer's recommendations.
 - b. The Contractor will construct thrust blocks behind all gasketed fittings, tees, bends, reducers, line valves, and caps in accordance with pipe manufacturer's recommendations. The Parks Irrigation Supervisor will inspect and approve all thrust block placements and installations. The Contractor will size thrust blocks as specified for each project:
- B. Control Wiring:
1. Low Voltage Wiring: The Contractor will:
 - a. Bury control wiring between controller and electric valves in pressure supply line trenches, strung as close as possible to the pressure supply lines. The Contractor will position this wire consistently below and to one side of pipe, or in separate parallel trenches.
 - b. Bundle all 24 volt wires at 10 foot intervals and lay with pressure supply line pipe or other pipe to one side of the trench.
 - c. Provide an expansion loop at every pressure pipe angle fitting, every electric control valve location (within the valve box), and every 500 feet. The Contractor will form an expansion loop by wrapping wire at least 8 times around a 3/4 inch pipe and withdrawing pipe.

- d. Make all splices and E.C.V. connections using 3M DBY or similar approved, dry splice method.
 - e. Install all control wire splices not occurring at control valve in a separate wire stub box.
 - f. Install one control wire for each control valve.
 - g. Run two spare #14 AWG UF control wires and one # 12 AWG UF common wire from controller pedestal to the end of each and every leg of the pressure supply mainline. The Contractor will label spare wires at the controller and at the wire stub box. Specification spare wires are in addition to spare wire stubs noted on Construction Documents.
2. High Voltage Wiring for the Automatic Controller: The Contractor will:
- a. Provide 120 volt power connection to the automatic controller.
 - b. All electric work shall conform to local codes, ordinances, and authorities having jurisdiction. All high voltage electrical work shall be performed by an electrician licensed in Arvada.
 - c. All electric lines underground will be installed in UL approved schedule 40 **P.V.C.** pipe with warning tape placed above the pipe.
- C. Automatic Controller: For city owned or controlled projects, the Contractor will:
- 1. Install the controller in accordance with manufacturer's instructions as detailed and where shown on Drawings.
 - 2. Connect remote control valves to the controller in the same numerical sequence that is shown on Drawings.
 - 3. Coordinate with the Parks Irrigation Supervisor for the review and approval of the final location for the controller prior to installation.
 - 4. Ensure that each controller installation shall include a dedicated separate ground wire and grounding rod, per the manufacturer's recommendations.
 - 5. Install all above-ground conduits with rigid galvanized pipe and appropriate fittings. Likewise, the Contractor will install all below-ground conduits with schedule 40 PVC.
 - 6. Furnish a temporary electric controller during the contract period.
 - 7. Upon completion of each project, the Contractor will remove the electric clock and install the city's Motorola controller. The Motorola controller will be purchased by the City (a cost which developers will reimburse to the city as a condition of approval for the irrigation system or as otherwise approved in a Development Agreement between the city and the developer.)

- D. Electric Control Valves – The Contractor will install the valve cross-handle 3 inches below finished grade where shown on Drawings and as detailed. (When grouped together, allow at least 12 inches between valve box sides.) Install each remote control valve in a separate valve box. Install each valve box lid flush with grade. All electric Control Valves will have a True-Union Ball Valve installed on the inlet side of the valve (see details.)
- E. Quick Coupling Valves – The Contractor will install quick couplers on double swing-joint assemblies of Schedule 80 PVC pipe, plumb and flush to grade. Angled nipple relative to pressure supply line shall be no more than 45 degrees and no less than 10 degrees. Install quick coupling valves as detailed.
- F. Drain Valves – The Contractor will install a Ford ¾-inch slotted, manual drain valves at locations shown on plans. Provide a six cubic foot drainage sump under each drain valve.
- G. Valve Boxes: The Contractor will:
1. Install one valve box for each type of valve installed as detailed. (Valve box extensions are not acceptable.) Install a gravel sump at each valve location after compaction of all trenches. Place gravel inside valve box after valve box is backfilled and compacted.
 2. Brand the controller letter and station number on the lid of each valve box. Letter and number size shall be no smaller than 1 inch and no greater in size than 1 1/2 inches. Depth of branding shall be no more than 1/8 inch into valve box lid.
- H. Gate Valves and Isolation Valves - Install where shown on Drawings as detailed.
- I. Sprinkler Heads - Install sprinkler heads in positions approved by the Parks Irrigation Supervisor. Set each head in the specified position relative to finished grade to comply with the Manufacturer's recommendation or as otherwise detailed. Spacing of heads shall not exceed the maximum indicated on the Irrigation Plans, unless approved by the Parks Irrigation Supervisor. Install heads on double swing-joint risers of schedule 40 PVC pipe. Angled nipple relative to non-pressure line shall be no more than 45 degrees or less than 10 degrees. Adjust part circle heads for full coverage of the landscaped area, avoiding paved surfaces. Adjust heads, as needed, to the correct height after sod is installed. Plant placement shall not interfere with intended sprinkler head coverage, piping, or other equipment. If a distribution problem is identified by the Parks Irrigation Supervisor or project manager, the Parks Irrigation Supervisor may request nozzle changes or other adjustments without additional cost to the City.
- J. Backfilling – The Contractor will not begin backfilling operations until all required system tests have been completed, except within 10 feet of trails or sidewalks. Backfilling shall not be done in freezing weather except with review and written approval by the project manager. Leave trenches slightly mounded a minimum of 2" above the adjacent finished grade or as mutually agreed upon by the Contractor and the project manager, to allow for settlement after backfilling is completed. Trenches shall be finish-graded prior to the irrigation system walk-through by the Parks Irrigation Supervisor and the project manager.
1. Materials - Excavated material is generally considered satisfactory for backfill purposes. However, prior to initiating the backfill operations, the

Contractor will ensure that the backfill material shall be free of rubbish, vegetation, frozen materials, and stones larger than 1 inch in maximum dimension, unless otherwise specified. Material not suitable for backfill shall be hauled away. Contractor shall be responsible for providing suitable backfill if excavated material is unacceptable or insufficient to complete the backfill, compaction, and final grade requirements.

2. The Contractor will not leave trenches or pits open for a period of more than 48 hours. Open excavations shall be protected in accordance with OSHA regulations.
3. The Contractor will compact backfill to 90% maximum Proctor Density (95% in areas that will be paved,) as determined in accordance with ASTM D155-7 utilizing the following methods:
 - a. Mechanical tamping.
 - b. Puddling or ponding and/or jetting are prohibited within 20'-0" of building or foundation walls.

K. Piping Under Paving - The Contractor will:

1. Provide for a minimum cover of 18 inches between the top of the pipe and the bottom of the aggregate base for all pressure and non-pressure piping installed under asphaltic concrete or concrete paving or other pavements.
2. Provide squeegee sand (a layer 6" below pipe and 6" above pipe) bedding under all pipe located under areas intended for new asphalt or concrete paving
3. Compact backfill material in 6" lifts at 95% Proctor Density determined in accordance with ASTM D155-7 using manual or mechanical tamping devices.
4. (If paving has not occurred) Set in place, cap, and pressure test all piping to the satisfaction of Parks Irrigation Supervisor prior to trench backfilling and paving operations.
5. Pipe under existing walks or concrete pavement by jacking, boring, or hydraulic driving. If the Contractor chooses to sawcut, demo and remove walks and/or concrete pavement, it shall be done and replaced at no additional cost to City with the project manager's permission.

L. Water Supply and Point of Connection - The Contractor will satisfy the City Utilities Standard Specifications for attaching to the city' water supply mains and extending the water supply into the project, as shown on irrigation plans.

M. Master Valves – Flow Units: The Contractor will install, per the Manufacturer's recommended specifications:

1. All Master Valves / Flow Units will be installed above ground – per details
2. All Master Valves / Flow Units will be A-ROD Valves, normally closed.

Field Quality Control - The Contractor will satisfy the following requirements:

- A. Flushing - After piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads and quick coupler assemblies, the Contractor will thoroughly flush the piping system under full head of water pressure from dead end fittings. Maintain flushing for 5 minutes through the end of all pressure lines and non-pressure lines. Once all contamination from the inside of the pipes is cleared, the Contractor will cap risers.
- B. Testing – The Contractor will conduct tests in the presence of Parks Irrigation Supervisor or a designated representative. The Contractor will coordinate with the Parks Irrigation Supervisor (or designated representative) 48 hours in advance of the testing. The Contractor will supply force pumps and all other test equipment. With a minimum of two pressure gauges (of 160 P.S.I.) or whatever the Parks Irrigation Supervisor deems necessary for an accurate test.
 - 1. After backfilling and installation of all valves, the Contractor will fill the pressure supply line with water, and pressurize it to 140 PSI, then hold that pressure without any loss of pressure and without any additional pressurization, for a test period no less than 2 hours.
 - 2. Leakage, Pressure Loss – The Parks Irrigation Supervisor will accept the Pressure Test if leaks are not detected and if no loss of pressure is evident during the test period.
 - 3. Leaks – If leaks are detected, the Contractor will repair them.
 - 4. Retest system- As needed, the Contractor will retest the system until test pressure can be maintained for duration of test and until all leaks are repaired.
 - 5. Before final acceptance, the Contractor will ensure that the pressure supply line shall remain under pressure for a period of 48 hours with static pressure. The Contractor is required to eliminate any water losses. The system will not be accepted until this requirement is satisfied.
- C. Walk-Through for Substantial Completion: The Contractor will:
 - 1. Arrange a first walk-through with the Parks Irrigation Supervisor and the project manager 48 hours in advance.
 - 2. Ensure that the entire irrigation system, piping and controls, shall be completely installed and operational prior to scheduling the first walk-through.
 - 3. Operate each automatic valve (zone) sequentially at the first walk-through and additionally, open all valve boxes during the test.
 - 4. Generate a list of items to be corrected or completed prior to Final Completion. The Contractor will communicate this list to the Parks Irrigation Supervisor, the Parks Supervisor and the project manager for the project for their confirmation of items on the list.
 - 5. Furnish all materials and perform all work required to correct all inadequacies of coverage due to deviations from Contract Documents.

- D. Walk-Through for Final Completion: The contractor will:
1. Arrange for the Parks Irrigation Supervisor and the project manager to attend the Final walk-through 48 hours in advance.
 2. Provide all specified accessories, charts, record drawings, and equipment to the Park Irrigation Supervisor or indicate, in writing to the Parks Irrigation Supervisor, the name of the city representative who received and signed for the same, prior to scheduling the Final Completion walk-through.
 3. Operate each zone, in its entirety for the Parks Irrigation Supervisor and the project manager during the Final Walk-Through to insure the completion of all corrected or incomplete items.
 4. Rework to the complete satisfaction of the Parks Irrigation Supervisor all Items deemed unacceptable, incomplete, or that otherwise fail to satisfy the project specifications.
 5. If the Parks Irrigation Supervisor finds items during the walk-through which have not been properly adjusted, reworked, or replaced as indicated from the previous walk-through(s), the project manager will determine the value of the work necessary for the Contractor to complete the project specifications and the dollar value of that work will be withheld from the final payment and/or payment of retainage to the Contractor.

40.3.9 Adjusting: The Contractor will:

Upon completion of installation, "fine-tune" the entire irrigation system by regulating valves, adjusting irrigation head patterns and break-up arms, and setting pressure reducing valves at pressures necessary to provide optimum and efficient coverage. The Contractor will flush and adjust all sprinkler heads for optimum performance and prevent overspray onto walks, roadways, and buildings as much as possible. The Contractor will ensure that irrigation heads of same type shall be operating at the same pressure +/- 7%.

- A. If it is determined that irrigation adjustments will provide proper coverage and improved water distribution as determined by Parks Irrigation Supervisor, the Contractor shall make these adjustments prior to Final Acceptance, as directed by the Parks Irrigation Supervisor or their representative at no additional cost to City. Such adjustments may include changes in nozzle sizes, degrees of arc, and control valve throttling.
- B. The Contractor will set all sprinkler heads perpendicular to finished grade unless otherwise directed for optimum performance.
- C. If elements of the system do not conform to the requirements in the specifications due to unauthorized changes or poor installation practices, the Contractor shall immediately make corrections at no additional cost to the City.

40.3.10 Cleaning

The Contractor will continue cleaning and other maintenance at the project site during active construction, consistent with conditions in the contract. As a minimum, the Contractor will dispose of, off-site at no additional cost to City, all trash or debris generated by installation of any irrigation system elements. However, the Contractor must understand that the city will not accept maintenance responsibility for any part of the

irrigation system until the Contractor has satisfied **all** project requirements. Until the city's acceptance, the Contractor is obligated to operate the irrigation system and to maintain new turf and new landscape that may be dependent on the irrigation system.

40.4 WARRANTY/GUARANTY

Each Manufacturer shall warrant materials against defects for a period of two years from the date of Warranty Commencement. The Contractor shall guaranty workmanship for a similar period.

- A. Settling of backfilled trenches that may occur during the guaranty period shall be repaired at no expense to City by the Contractor, including complete restoration of damaged property to the satisfaction of the project manager or Parks Irrigation Supervisor or other City representative.
- B. The Contractor will respond in writing within 24 hours of notification to each Parks Irrigation Supervisor request for repairs within four (4) calendar days after notification, or the City will complete the work and bill the Contractor for the value of the work plus overhead. During the Contractor's repairs, the Contractor is responsible for damage to landscape and turf related to the interruption of irrigation system service.
- C. All repairs and cleanup expenses due to vandalism before substantial completion shall be borne by Contractor.
- D. Parks Maintenance staff will maintain turf and planting areas during the warranty period, so as to ensure proper operation of irrigation system.

40.4.1 Maintenance

- A. The Contractor will furnish the following maintenance items to the Parks Irrigation Supervisor or their representative prior to Final Acceptance:
 - 1. Two (2) sets of special tools required for removing, disassembling, and adjusting each type of sprinkler head and valve supplied on the Project, if applicable.
 - 2. Two 6-foot long valve keys for operation of gate valves, isolation valves or stop and waste valves, if applicable.
 - 3. Two (2) keys for each automatic controller enclosure, if applicable.
 - 4. Two (2) quick coupler keys and two (2) matching hose swivels for each type of quick coupling valve installed, if applicable.
- B. Winterization – Contractor shall include in their bid their cost to winterize the complete system at the conclusion of the first sprinkling season during which the system received Final Acceptance. Contractor winterization shall be within three (3) work days after notification by the Parks Irrigation Supervisor or their representative. The Contractor will remove all water from the system using compressed air or a similar method approved by the Parks Irrigation Supervisor or their representative. Likewise, the Contractor will recharge, operate, and adjust the irrigation system, repairing any malfunctions encountered, during April of the following season on a date within seven (7) calendar days of notification by Parks Irrigation Supervisor or their representative.