808 WATER DISTRIBUTION

808-1 Description

An efficient irrigation system is the result of and depends upon, proper design, installation and maintenance. A successful installation depends upon careful and thorough inspections.

Irrigation has been defined as "the controlled application of water to soil for the purpose of supplying the moisture essential for plant growth." An irrigation system applies the right amount of water to a specific area or plant so that it can be utilized by the plant material with little or no water loss.

Irrigation systems are designed to produce optimum soil moisture levels and encourage maximum plant growth. The use of irrigation in ADOT is to sustain landscape life over a period of time. The application rates of irrigation systems are designed to provide the maximum moisture requirements for plants. Properly designed and installed irrigation systems distribute water uniformly over the intended planting area at a predetermined precipitation rate.

A variety of factors influence the efficiency of a system's operation and must be taken into consideration during the design stage. Carefully inspect the installation of all irrigation systems to ensure that the system not only follows the design intent, but also fully conforms to the Special Provisions, Project Plans, Standard Specifications, and the manufacturer's requirements and recommendations.

The Department installs three types of systems. They are listed in their order of installation frequency; emitter, bubbler, and turf sprinkler systems. The water conservation regulations and State laws are slowly eliminating turf sprinkler systems in desert areas. Low pressure and less water consumptive emitter and bubbler systems are being established as the standard.

Additional methods of watering include temporary and flood irrigation systems. Truck watering systems are temporary systems used to irrigate plant materials on roadways without accessible water lines. Flood irrigation is used where water is available and supplied by the city. There is usually an agreement in place to authorize this method.

Emitter systems apply water at low pressure and flow rates to avoid ponding, puddling or runoff and are designed in a variety of configurations. The "rigid pipe system," installed by ADOT is comprised of Polyvinyl Chloride (PVC) pipe laterals with flexible polyethylene supply and flexible distribution lines. It is important to examine the irrigation plans carefully, since they vary from project to project.

In bubble and turf sprinkler systems, the laterals are PVC while risers are flexible PVC or swing joints. Bubbler heads could have a manually adjustable flow rate or are the non-adjustable pressure compensating type. Integration of bubblers, sprinklers and emitters on a common valve circuit is not recommended because emitters irrigate in gallons per hour (GPH) while bubblers/sprinklers irrigate in gallons per minute (GPM). Run times for bubblers and sprinklers vary, so even though they are both measured in GPM, it is not advisable that they water on the same system.

Additional components found in irrigation systems may include water meters, backflow prevention devices, manual and automatic valves, controllers, pressure regulators, check valves, flush caps, sleeves, drain valves, air/vacuum release valves, isolation valves, piping, ball valves, etc.

808-2 Materials

808-2.01 Components

A. Backflow Prevention

Backflow is the unwanted reverse flow of liquids or solids in piping systems. Backflow is the result of either back pressure or back-siphonage. Irrigation systems are a potential source of pollution to a potable system. Backflow prevention is the process of separating the potable water from the irrigation system. By installing a backflow preventer, the possibility of contamination to the potable water system is greatly reduced.

Some jurisdictions require backflow preventers with reclaimed water. Locations in freeze zones may require insulation and seasonal draining. Requirements will vary from area to area.

Backflow prevention for an ADOT system is supplied using a Reduced Pressure Assembly (RPA). This assembly consists of two independently operating check valves. There is an automatic operating pressure differential relief valve located between the two valves.

Reduced Pressure Assembly

An RPA is designed to protect against backflow, back-siphonage and backpressure. It is utilized where there is a high risk for hazard and is a standard for commercial irrigation installations. The unit must be installed 12 inches above ground and is not required to be higher than outlet devices downstream of the unit. The single unit is installed upstream of all valves and is designed to release water through the relief valve.

Upon installation of the backflow prevention unit and prior to the Contractor using any water from the cities' supply, the device shall be tested by an authorized and city approved tester.

The backflow component shall be tested before acceptance of phase I and phase II, and following any repairs or service to the device.

Backflow prevention units should be tested whenever they are taken out of service and returned at a later date (for example, removing the unit during winter months to prevent freezing). If a backflow prevention device requires repair or replacement, re-testing is always required prior to putting the unit back into service.

Certified Testers will use the RPA manufacturer installed test cocks to examine the device for proper operation.

Pressure Vacuum Breaker

A pressure vacuum breaker (PVB) is designed to protect against backflow and back-siphonage. It is installed on the mainline leading to the control valves. The PVB contains a single body that houses a single loaded check valve and a loaded air-opening valve. The air valve opens for ventilation whenever the pressure within the body approaches atmospheric. The valves are designed to be under continuous pressure and must be installed 12 inches above any distribution of water downstream of the device.

A single PVB must be installed on the mainline leading to the control valve.

Atmospheric Vacuum Breaker

The atmospheric vacuum breaker (AVB) is designed to prevent back-siphon age only. It is installed directly after a remote control or gate valve and is not meant to be under continuous pressure. This type of back-siphon age preventer is rarely found on ADOT projects. However, it may be encountered on retrofit projects.

This device has no shut off, gate valve or remote control valve downstream of the instrument. It must be installed above ground and must be 6 inches higher than the tallest sprinkler head controlled by any of the valves.

In a sloped yard, it is installed at the top of the slope, with a pipe running to it from a water source and then down to the emitters or sprinklers.

B. Controllers

Controllers are manufactured and designed to automate an irrigation system. The system is activated by setting the current day, time and year. The controller needs to establish an irrigation schedule, program the time of day, the number of watering times per week, and the length of time each valve operates. This timetable constitutes a program.

Programs run independent of one another. For example, one program may require daily watering, while another program irrigates every third day, and yet another waters once every ten to fourteen days. The use of automatic control to maintain an efficient watering program is a requirement for systems where water conservation is desirable or necessary.

Controllers come in a variety of configurations from electro-mechanical to complete computer units. The controller commonly used in Phoenix and Tucson metro area by ADOT is the Motorola Irrinet (MIR-5000i) or Scorpio (MIR-5000s). The controllers are connected through radio transmission to a central satellite system that monitors the irrigation system (see System Overview of MIR 5000i on Exhibit 808-2.01-1).

While both the Irrinet and Scorpio units can be utilized as stand alone controllers, only the Irrinet is capable of communicating with the central satellite system. Scorpio controllers communicate with Irrinet, which in turn passes the information to the central system. It is necessary for the Irrinet and Scorpio to be within the "line of site" or one another to enable them to communicate.

Other controllers are solar, battery or electrically powered. Solar and battery operated controllers have different latching solenoids and are attached to a variety of manufacturer remote control valves. Inspectors will have to consult the manufacturer's specifications for each type of controller.

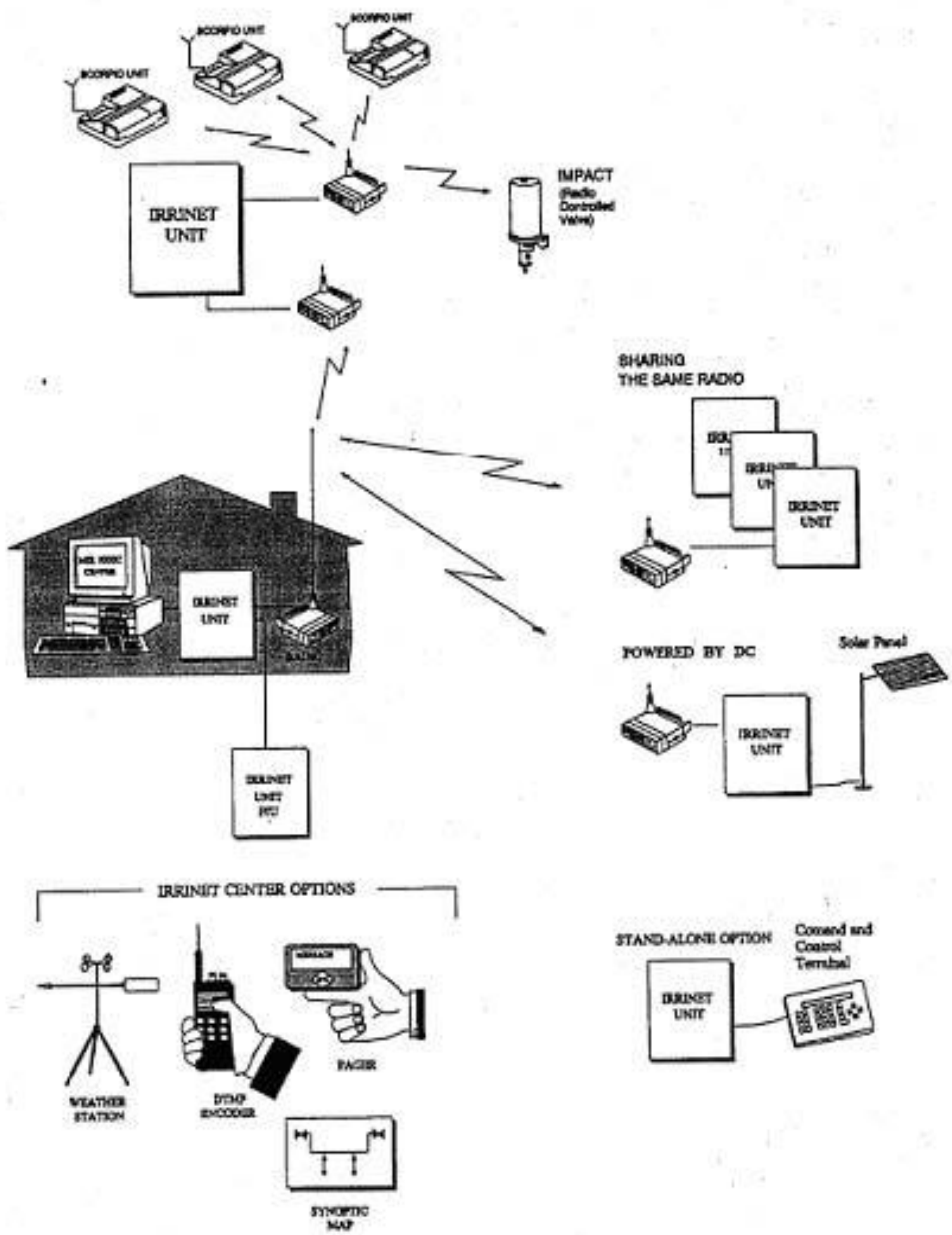


Exhibit 808-2.01-1. System Overview of MIR5000i Motorola Irrinet

C. Filters

Filters sift water entering the irrigation system by removing small foreign particles that could clog the irrigation system. The openings in emitters are small and can plug easily. Once clogged, the emitters will not deliver water to the intended plant material, potentially causing the plant material to die. Filters strain water according to the mesh size of the screen.

ADOT installations require the filter/strainer to be installed after the backflow device. However, some municipalities have the filter installed before the backflow preventer, while others install the filter downstream of each control valve.

Filter screens are rated by ‘mesh’. The term ‘mesh’ applies to woven wire cloth and is used primarily for very fine straining. An example: 100 mesh means 100 vertical and 100 horizontal strands of wire to the square inch, resulting in 10,000 openings of .0055 square inches. Mesh typically comes in the following sizes:

Mesh	Openings per Sq. in.
20	0.033
30	0.023
40	0.0165
50	0.0117
60	0.0098
80	0.0078
100	0.0055
140	.0041
200	.0029

The Inspector must read the Special Provisions to determine which type of mesh has been specified. The Inspector must visually check the filter to verify that the mesh is as specified. Filtration product labeling will vary between manufacturers. Inspectors are required to review the manufacturer product literature contained in the Contractor submittals to ensure that the correct filter is installed.

D. Emitters

Emitters are instruments that regulate the amount of water the plant material receives. They are located downstream of the control valve and pressure regulator, and are connected to the lateral irrigation pipe.

Emitters are configured as single, multi-outlet, or in-line units. A multi-outlet emitter has six to twelve outlets on a single device. In-line emitters are manufactured inside of polyethylene tubing. Their watering and spacing requirements will vary based on the designer specifications.

Emitters are also available with pressure compensation. A pressure compensating emitter has the same output regardless of the inlet pressure. For example, a 1 GPH pressure compensating emitter will discharge 1 GPH, whether the inlet pressure is 30 psi or 50 psi (per square inch).

The amount of water released through each outlet is measured in GPH. Normal settings for emitters are 0.5 GPH, 1.0 GPH and 2.0 GPH. Manufacturers color code emitters according to the out-put. Inspectors will have to check the project plans emitter schedule and read the product literature to ensure that the correct gallonage is being installed.

E. Sprinklers

Sprinklers are used to irrigate and distribute water over turf areas in parks, soccer fields, ground cover and retention areas. The water is distributed to the area in a reasonably uniform pattern. Too little watering on any portion of an area can result in localized dry spots.

Sprinklers are rated in gallons per minute and range from .5 GPM to 4 GPM for spray heads and 1.2 GPM to 30 GPM for gear driven rotors. A gear driven rotor is a larger sprinkler head used in a wide area of residential applications. The rotor is 8 inches tall with a 4 inch pop-up height and disperses water from one to three nozzle openings. The spray heads are 4-12 inches tall with a pop-up height of 2-12 inches.

The spacing of sprinklers depends on the radius of throw for an individual head. For example, if a spray head has a radius of 12 feet, then the heads should be spaced at a distance of no more than 12 feet. Sprinklers should never exceed a manufacturer's suggested sprinkler spacing recommendation.

F. Flow Sensors and Monitors

Flow sensors track and monitor the amount of water used by an irrigation system. Sensors can detect and shut down the system in the event a valve does not turn off as programmed or if an irrigation line breaks. Flow sensors are located downstream of the backflow preventer and upstream of the control valves.

The flow sensor is an inline component with an impeller that comes in contact with the water. As the impeller rotates, it sends a signal out to a monitor that is calibrated to the pipe size and number of gallons or cubic feet per pulse.

Installation according to manufacturer's recommendations is always advised. The general rule is that there be a minimum of 10 pipe size diameters of straight pipe upstream from the first flow sensor and 5 pipe size diameters of straight pipe downstream. This helps prevent turbulence in the water, which could cause the device to malfunction.

A monitor is used to condition the signal from the sensor to a pulse which the controller reads as 1 or 10 gallons of water. The controller compares this flow quantity to the pre-set norms. An alarm is sent if the actual flow is outside of the norm by a given percentage. The central computer is then updated by radio.

G. Pressure Regulators

The pressure regulator is designed to convert the inlet water pressure to a lower outlet pressure. Depending upon the system, the pressure regulator can be located downstream of the backflow preventer or at each control valve.

Adjustable Pressure Regulator

Pressure regulators are available as adjustable or pre-set. An adjustable pressure regulator is constructed of brass or PVC. The unit comes from the factory at a pre-set per square inch (psi) and can be adjusted higher or lower. The valves inlet pressure rating will vary by manufacturer from 150 to 400 psi with an outlet pressure from 25 to 75 psi.

Pre-Set Pressure Regulator

The pre-set pressure regulator is constructed of plastic. Pre-set pressure regulators come in a wide range of operating pressures. Depending on the manufacturer, the system can have a range of 80120 PSI inlet pressure and an outlet pressure that is set from 15 to 50 PSI. The flow of the regulator could be as low as .320 GPH, or increase to 22 GPM (1320 GPH).

H. Valves

Valves are available in a variety of styles. The common factor is the ability to allow water to flow.

1. Master Valve:

   The master valve controls the entire irrigation system and is located downstream of the backflow preventer. It is an automated valve that responds to commands issued by the controller. The master valve will allow the system to flow or shut down the entire system.

2. Remote Control Valve

   Remote control valves (RCV) are similar to master valves because they react to commands issued by the controller. The difference is that they control only one portion of the system. An irrigation system can be composed of any number of remote control valves. The controller opens one RCV after another, for a programmed duration, until an entire area has been irrigated. Motorola controllers are capable of opening multiple valves on one program.

   The controller sends a 24-volt signal to the magnetic solenoid located on the RCV. When the signal is sent, the magnet energizes and lifts the plunger up off of its seat, allowing water to bleed off of the top of the diaphragm. This action allows the RCV to open. The RCV remains open as long as the signal is received from the controller. When the signal stops the plunger in the solenoid drops, effectively stopping the water flow and forces the RCV to close.

   The remote control valves are equipped with a flow control valve and two manual bleed valves. The flow control valve limits the amount of travel the diaphragm has inside of the valve. This will in turn limit the flow.

   The manual bleed opens the valve without using the controller. One manual bleed allows water to bleed from the top of the diaphragm to the atmosphere. The internal valve bleeds down through the valve into the pipe. This prevents the valve box from being filled with water.

   The manual valve directed to the atmosphere should be used to operate the RCV. Upon its initial opening, debris will be flushed from the system helping to avoiding a clogged solenoid.

   This step should be followed the first time the RCV is operated. After the initial opening, the internal valve may be used.

3. Pressure Release Valve

   Pressure release valves are used on mainline pipes to release water when the pressure in the mainline exceeds a set value. They are used to prevent a buildup of excessive surge pressure when a line is filling up or when a valve closes too quickly.

4. Isolation Valve

Isolation valves are either gate or ball valves. Both valves are used to stop the flow of water to specific parts of the irrigation system. The ball valve requires a quarter of a turn to completely shut down while a gate valve needs to be turned several times before shutdown is accomplished.

To prevent water hammer in the system, exercise caution when operating ball valves by opening and closing them slowly.

Isolation valves are used on separate parts of the system. If a leak occurs in one section of the system, it can be shut down while the rest of the system remains operational.

Isolation valves are designed to be either fully open or fully closed. They are installed upstream of the remote control valve. If the remote control valve requires repair or replacement, a single RCV may be shutdown rather than the whole system.

The manufacturer installs ball valves on the inlet and outlet of the RPA. The valves are used to shut the device down as well as for testing the device to ensure that it is operating properly.

5. Check Valve:

Check valves are in-line valves that prevent the reverse flow in a piping system. The following configurations are available:

Spring loaded
Adjustable spring loaded
Swing or flapper

Check valves are installed to prevent low head drainage in a turf irrigation system. Check valves are often built into the base of a turf rotor and will check up to 15 feet of elevation change. In case of an elevation change, this prevents water from draining from the head.

6. Blow-Off Valve:

Blow-off valves are ball or gate valves placed at the end of a mainline. The valves are opened up on occasion to allow a flushing of an irrigation system. The system is flushed to prevent contaminants from plugging up the system.

7. Quick Coupler Valves:

Quick coupler valves provide supplemental water at various locations around a site. They are installed directly on the mainline and are under constant pressure. The valves are operated using keys that screw inside of the coupler. When attached, the coupler forces the valve open and allows water to flow. The keys have a sprinkler head or a hose adapter attached to distribute water where needed.

8. Schrader Valve

A Schrader valve is used to measure the psi pressure in a system. It is the same equipment used to measure air pressure in vehicles tires.

I. Bubblers

Bubblers, like emitters, regulate the amount of water plant materials receive and are measured in gallons per minute. Bubblers are available in two configurations, adjustable or pressure compensating. Adjustable bubblers have variable operating ranges from being closed to 5 gallons per minute. Pressure compensating bubblers have an operating range of .25 to 2 gallons per minute. The outlet pressure remains the same regardless of the inlet pressure.

J. Pipe Types

PVC is offered in a variety of sizes. Selection depends upon the amount of pressure the system will be operating under. The following types are commonly used at ADOT:

Schedule 80

Nominal Pipe Size in inches	Outside Diameter	Inside Diameter	Min. Wall Thickness	Max Working Pressure (PSI)
½	.840	.546	.147	850
¾	1.05	.742	.154	690
1	1.315	.957	.179	630
1 ¼	1.6660	1.278	.191	520
1 ½	1.9	1.5	.2	470
2	2.375	1.939	.218	400
2 ½	2.875	2.323	.276	420
3	3.5	2.9	.3	370
4	4.5	3.826	.337	320
6	6.625	5.761	.432	280

Schedule 40

Nominal Pipe Size in inches	Outside Diameter	Inside Diameter	Min. Wall Thickness	Max Working Pressure (PSI)
½	.840	.622	.109	600
¾	1.05	.824	.113	480
1	1.315	1.049	.133	450
1 ¼	1.6660	1.38	.140	370
1 ½	1.9	1.61	.145	330
2	2.375	2.0679	.154	280
2 ½	2.875	2.469	.203	300
3	3.5	3.068	.216	260
4	4.5	4.026	.237	220
6	6.625	6.065	.280	180

Class 200

Nominal Pipe Size in inches	Outside Diameter	Inside Diameter	Min. Wall Thickness	Max Working Pressure (PSI)
¾	1.05	.930	.060	200
1	1.315	1.189	.063	200
1 ¼	1.6660	1.502	.079	200
1 ½	1.9	1.72	.090	200
2	2.375	2.149	.113	200
2 ½	2.875	2.601	.137	200
3	3.5	3.166	.167	200
4	4.5	4.072	.214	200
6	6.625	5.993	.316	200

½ inch PVC pipe is not manufactured in Class 200. However, it is available in Class 315.

PVC can be either bell end or ring-tite. Bell end pipe is welded together with solvent. Ring-tite uses a rubber gasket to seal against leakage. Ring-tite pipe has a groove built into the bell end of the pipe. The installed gasket forms a tight seal against the male end of the pipe.

The range of pressure rating for plastic pipe materials is referred to as the Standard Dimension Ratio (SDR). SDR is the ratio of pipe diameter to the minimum wall thickness. It is used to classify pressure class plastic pipe. SDR rated pipe of the same pipe materials and at standard temperature will have the same pressure rating for all pipe diameters. For example, Class 200 PVC pipe has an SDR rating of 21.

K. Lateral End Cap

This end cap is used to manually flush the emitter laterals. The end cap is constructed using Schedule 40 fittings, one socket slip by ¾ inch male hose thread (MHT) and a female hose thread (FHT) cap. The riser from the lateral to the end cap is Schedule 80/Schedule 40 flexible PVC. Lateral lines are installed with a flush cap at the end of each line. This allows for build-up removal.

808-3 Construction Requirements

Thorough inspections, carefully conducted during construction, help ensure the proper installation of irrigation systems. To be adequately prepared to inspect the installation it would be beneficial for the Inspector to be knowledgeable in at least one facet of irrigation design, installation, and/or maintenance.

Exhibit 808-3.1 illustrates typical landscape symbols utilized on irrigation plans.

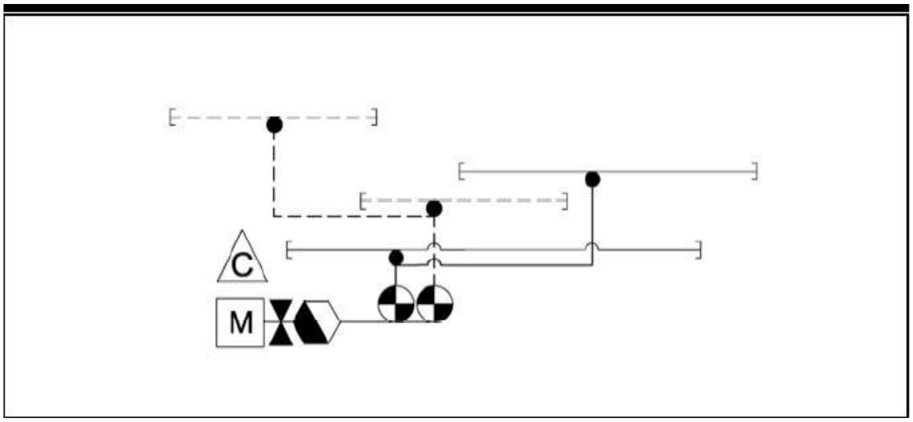
If this is not possible, the Inspectors should familiarize themselves with the sections of the Standard Specifications, contract documents and bid schedule that pertain to inspection of irrigation systems before attempting the necessary inspections. In addition, it is advisable for the Inspector to obtain additional advice and/or assistance from department representatives having expertise in these specialty areas.

An initial inspection shall be conducted on all irrigation system components, as they are delivered to the project site, to determine acceptance or rejection. The Inspector must check the components against the approved submittal list. If at any time, until final acceptance, components are damaged, defective, or not formally approved for use on the project, shall be rejected and removed from the project site. Irrigation submittals indicating acceptance or rejection of components shall be properly documented and maintained by the Inspector at all times.

Irrigation systems have similar components. However, layouts will vary based on the individual project site. All systems, temporary or permanent, begin at the water source. Most systems will go from the water source to a water meter, from the water meter to the backflow prevention device, from the backflow prevention device to a control valve, and from the control valve to emitters.

The irrigation controller is often located adjacent to the backflow prevention device. The final destination will depend on the location of the electrical power source. There may be other components included in an irrigation system. The items can include flow sensors, fertilizer injectors, pressure regulators, filters, coupling, check and isolation valves.

Irrigation components and their locations are represented by landscape symbols in the irrigation plans.



Irrigation Symbols

IRRIGATION LEGEND

SYM	MANUFACTURER	MODEL	DESCRIP.
	MOTOROLA	IRRnet	IRRIGATION CONTROLLER
M	BY OTHERS		METER
	NIBCO	T-555-Y	BALL VALVE
	FEBCO	825YA	BACKFLOW PREVENTION ASSEMBLY
	RAINBIRD	PEB SERIES	REMOTE CONTROL VALVE
	HENCRICKSON	DG 5025	PRESSURE REGULATOR RISER
N/S	BOWSMITH	ML06	.6 GPH MULTI-OUTLET EMITTER
N/S	BOWSMITH	SL206	.6 GPH SINGLE OUTLET EMITTER
	SPEARS	M-66-P/AP-100	END CAP
	MAINLINE	SCHEDULE 40	
	TREE SUBMAIN	1" CLASS 200	
	SHRUB SUBMAIN	1" CLASS 200	
	TREE LATERAL	3/4" CLASS 200	PVC SLEEVE
	SHRUB LATERAL	3/4" CLASS 200	
		SCH. 40 PVC	PVC SLEEVE

Exhibit 808-3-1 Symbols Legend

The Inspector must verify that the proper municipality has been advised that a tap will be made into their infrastructure. The Inspector shall keep a diary of contact information for each tap. A city representative must be present for each tap. If a municipality conducts its own tap, that information should be documented in the Inspector's diary.

The Inspector must verify that the Contractor has contacted Blue Stake prior to any excavation. Blue Stake was established as a one call notification and prevention service to avoid damage to underground facilities. Blue Stake marks all utilities and underground facilities for the Contractor.

When the project has been Blue Staked, the Contractor is responsible for laying the system out on grade. The layout must show the locations and routing of the irrigation backflow prevention assemblies, mainline, isolation valves, sub-main, emitter laterals, remote control valves, pressure regulators, end caps, etc. The ADOT Inspector shall approve the system prior to installation.

The layout should take into consideration all conflicts with staked utilities and avoid conflicts whenever possible. Layout is performed at no additional cost. Planting pits, beds and turf areas shall be laid out, approved and prepared prior to staking the irrigation system. If adjustments to the system are required, the Contractor must provide a system that will leave no dry areas or un-watered plants.

The irrigation system routing will be determined after the plant locations have been approved. This will eliminate any conflicts between irrigation piping and planting pits. The minimum distance allowed between the edge of the plant pit and piping is 12 inches or as specified in the Standard Specification, Special Provisions or the project plans. The supply tubing lengths indicated on the project plans will determine the maximum distance.

In emitter systems, laterals should run between or adjacent to rows of plants. Emitter supply tubing connects the lateral line to an emitter that is placed near the plant pit or in an area of multiple plants. To assure proper water supply, unless otherwise noted, the maximum length of the supply tubing for a single port emitter is 25 feet. The maximum length of the supply tubing for a multi-port emitter is 20 feet.

Distribution tubing is usually placed in shallow trenches with the delivery end above grade at the planting pit. Tubing left exposed to direct sunlight can prematurely break or crack. Additional distribution tubing will make the final delivery of the water to the plant. Unless otherwise noted, the maximum length of any distribution tubing, after the emitter, is 12 feet or as detailed on the plans. Longer tubing lengths may cause a loss in pressure.

The Contractor shall furnish to the Resident Engineer, prior to installation, all installation instructions as published by the plastic pipe and fitting manufacturers. Prior to the install, the Inspector shall review and become familiar with the installation instructions. Installation of PVC piping and fittings shall be in accordance with the manufacturer's published instructions and the project construction documents or as directed by the Resident Engineer.

The emitter lateral end cap assembly shall be installed at the locations indicated on the project plans and in accordance with the requirements as stated in the Special Provisions. A lateral pipe should always end at a flushing end cap.

The Contractor shall furnish and install T-posts, or other posts approved by the Resident Engineer, as ADOT end cap markers. The markers are used only on end caps 30 feet behind the travel lane edge. The markers must be driven at least 24 inches into the ground, with a height at 30 inches above the ground level.

The Inspector shall tabulate all quantities of in-place irrigation system materials and components prior to backfilling. In addition, all information supplied by the Contractor to produce the as-built plans in regard to component quantities, sizes and locations shall be verified by the Inspector prior to backfilling.

The Inspector should know which items are to be compensated for under the contract. The Special Provisions detail what is to be paid for and what is considered incidental to the cost of an item under each item number. An example is the end caps. Their cost is included in the cost of irrigation pipe. A statement in the Special Provision may read "No measurement or payment will be made for the emitter lateral end cap assemblies. The cost for these items is included in the cost paid under this item."

808-3.01 Materials and Equipment

Prior to beginning work on a project, the Contractor shall submit a list of materials and equipment for approval. A partial listing of materials/components requiring review and approval is shown on Exhibit 808-3.01-1. The list is submitted at the pre-construction conference and includes the manufacturer, model numbers and product specifications. Copies of all documents must be submitted for distribution to departments within ADOT and to the irrigation designer for review and approval. Only material that has been submitted and approved may be stored or used on the project. Once construction begins, it is the Inspectors responsibility to ensure that the Contractor is installing approved equipment and materials.

All components intended for use in an irrigation system must receive approval from the Designer or Resident Engineer. ADOT Inspectors are responsible for verifying that the correct equipment is received and installed by the Contractors. At each delivery Inspectors shall verify that items used on the project are outlined on the submittals.

Approval of items is based upon information supplied by the Contractor within a pre-determined period of time as indicated in the Special Provisions. All components of the irrigation system shall be listed and identified by the corresponding bid item. Information must be included to identify each item listed. The following items should be highlighted to help the Inspector identify that the correct materials have been delivered:

- sizes
- specifications
- manufacturer name
- instructions
- model number
- design data
- options

Copies of the catalog cut sheets of all listed items shall accompany the Contractor's submittals. The designer will either approve or reject the items. A questionable item shall not be installed on the project without approval. Re-submittal is necessary until approval is granted. One copy of the submittal will be retained as an office file copy and one copy will be distributed to the designer. The remaining copies will be distributed by ADOT as needed.

It is the Contractor's responsibility to obtain and submit samples required for preliminary evaluation to the Resident Engineer, if necessary. The items will be submitted to the appropriate testing facility.

This **partial list** of materials along with any additional components of the irrigation system and equipment must be reviewed and approved prior to installation.

- Backflow Preventer
- Backflow Preventer Enclosure
- Enclosure Lock and Key
- Flow Monitor
- Master Valve
- Remote Control Valve
- Pressure Release Valve
- Isolation Valve
- Pressure Regulator
- Emitters
- Control Wire
- Bedding Sand
- Backfill material
- Copper Pipe & Fittings
- PVC Pipe & Fittings
- Steel Pipe & Fittings
- Solvent Cement
- Primer/Cleaner
- Fertilizer Injector
- Insulation and Metal Jacketing
- Pressure Gauge Assembly
- Nipples
- PVC Couplings
- Valve Boxes
- Isolation Valve Key
- Check Valve
- Blow Off Valve
- Quick Coupler
- Irrigation Controller
- Controller Enclosure
- Irrigation Controller Enclosure
- Filters (Mesh Size)
- Fertilizer Injector
- Antenna & Tower
- Bubbler Heads
- Circuit Breaker & Enclosure
- Conductor
- Conduit & Fittings
- Ground Rod & Clamp
- Hose Bib
- Pipe Insulation
- Pressure Gauge
- Pull Box
- Schrader Valve
- Swing Joint
- Emitter Supply & Distribution Tubing
- Wire Connectors

Exhibit 808-3.01-1. Partial Materials List

The Material Checklist, provided by the Materials Group, identifies which items require testing.

The Contractor is required to submit to the Inspector all maintenance manuals, warranties, guaranties and operation manuals from all equipment prior to acceptance of the project.

808-3.03 General Requirements

Trenches should be excavated to a required depth and be relatively smooth to provide support along the entire length of pipe to be installed. The Inspector should do a visual inspection of the trench to ensure that a smooth surface is present. The trench shall have no deflections or sudden turns unless a fitting is planned to make a change in direction. The bottom of the trench must be free from large or sharp rocks, roots or any foreign material that would prevent proper bedding of pipe or other facilities.

Depths and separation of piping must be as shown on the plans. Trench width may vary with the number of pipes in the trench and soil type. There should be a minimum of 2 inches provided between pipe and trench wall or between pipes. Pipe that is not properly bedded or that has any hard material resting adjacent to the pipe can cause the pipe to weaken. Water flowing through the pipe will create vibrations causing the pipe to rub against the hard materials.

The bedding and cover shall be of sand, and to the dimensions specified on the project plans. Gradation shall be as specified in the Standard Specifications, Subsection 808-3.04.

The Inspector should clear off the trench sides and lay a straight edge across the channel. The following measurements should be taken:

- Trench bottom
- Top of bedding
- Top of pipe
- Top of cover material

The measurements are used to confirm that minimum standards are being met.

Backfill material is used to fill the trenches after the bedding and cover materials have been placed. The backfill material should be excavated material that is free from all large or sharp rocks, and any foreign material 2 inches in diameter or greater. All material should have a smooth rounded surface to prevent PVC punctures.

All trenches excavated for the irrigation systems shall be backfilled within five working days from the day of initial excavation. Barricades shall be placed by excavated ditches located within 30 feet of the traveled way in a manner acceptable to the Resident Engineer. Open ditches beyond 30 feet from the traveled way shall be delineated and protected in a manner acceptable to the Resident Engineer.

The Inspector shall be responsible for taking a four-foot section of pipe for every 5000 feet installed. The pipe is used for testing and keeping track of pipe installed on the project. The pipe will have the stationing and the area that it was taken from written directly on it.

Pipe should be stored in an area without direct sunlight and with adequate ventilation to prevent overheating. Plastic pipe and fittings should be stored in a way that prevents damage by crushing or piercing. PVC pipe should be free of cracks and not be discolored in any way. PVC pipe darkened by the sun must be rejected.

Any portion of the pipe that is bent, dented, grooved or damaged, in any way, should be cut out of the section and discarded. Pipe should be square cut and free from all burrs before installation.

PVC piping for water or irrigation systems is joined by solvent welding or with ring-tite fittings. Assembly of pipe fitting shall be in accordance with manufacturer's instructions and project documents. Careful inspection and enforcement of assembly procedures are essential.

Solvent welding is a technique used to glue or bond PVC pipe and fittings together. Shake or stir the cement before using. *(Note: If the cement has a jelly like consistency, it should be discarded)*. A ¾ inch dauber should be used on smaller diameter pipes. For larger pipes, increase the size of the dauber to accommodate the pipe.

The pipe fittings should be cleaned and primed using a solvent or primer. Remove all dirt, oil, moisture and gloss from the surface of the pipe. *(Note: Primer is used to soften both pipe and fittings prior to the application of cement)*.

Apply a coat of primer to begin softening the pipe and fittings. Primer should only be applied to the male and female ends that will come in contact with one another. While the primer is still wet, use the appropriate sized applicator to quickly and evenly coat the cement to the pipe and fitting. *(Note: Best results are achieved when the cement is "flowed" on the pipe surface- not thinly brushed).*

Working quickly, insert the pipe into the fittings until it stops. Give the pipe a ¼ turn to help evenly distribute the cement. The cement on both the pipe and fittings must be fluid at this time or a failure may occur later.

To help prevent the tapered fittings from pushing away from the pipe, apply pressure to the pipe and fitting for 15 seconds to 3 minutes. Larger pipes may require assistance to help push the pipe together. The cement should appear to "wet" the surfaces of the pipe and fitting when assembled.

Remove excess cement with a dry rag to help prevent the pipe from weakening. A wet bead of cement on the outside of the fitting indicates that a sufficient amount of cement has been used and that the cement was fluid when assembled.

When working with bell end pipe, make sure excess cement does not puddle in the end of the socket. The excess cement can weaken the pipe causing leaks or breaks to form in the sidewalls of thin schedule and bell end pipes.

Follow the manufacturer's recommendations for solvent welding procedures. The set joint must be treated carefully during the initial curing time, and not distributed. For convenience, pipes are usually assembled above ground and then lowered into the prepared trench.

If the pipe is assembled above ground, the Inspector needs to be sure the solvent cement joints have had enough time to set before the pipe is moved or tested. The following tables are the estimates for Average Initial Set Times.

The information can be located at IPS Weld-On website, www.ipscorp.com

Average Initial Set Time

Temperature Range	Pipe Size ½" to 1 ¼"	Pipe Size 1 ½" to 2"	Pipe Size 2 ½" to 8"
60° - 100°	2 minutes	5 minutes	30 minutes
40° - 60°	5 minutes	10 minutes	2 hours

Note: *Initial set schedule is the necessary time to allow before the joint can be carefully handled. In damp or humid weather allow 50% more set time.*

There are a variety of pipe solvent/cements available. The application will vary depending on the type of pipe being used. The Inspector should be familiar with the types of cement used for each type of pipe. The manufacturer's cut sheets will provide guidelines.

At the end of each day, the pipe ends should be capped to prevent unwanted debris or animals from entering. Prior to backfilling, snake the pipes from side to side in the trench to prevent expansion failures. Walk the length of pipe and record the installed footage in the daily diary.

Wrap all threaded joints with Teflon tape or a manufacturer's recommended sealant/lubricant compatible with the part being installed. This will prevent water from leaking around the threads.

Electrical control wires between the automatic controller and the automatic control valves shall be bundled together at 10-foot intervals in the trench. The wires shall be placed either adjacent to or beneath the irrigation mainline to protect against possible damage from future excavation.

Sufficient wire slack shall be maintained to eliminate wire stressing or breakage. Variations in moisture content or extreme seasonal temperature fluctuations cause the expansion or contraction of wire and/or earth. Wire shall be provided with a 36 inch loop at all changes in directions and on both sides of sleeve crossings. Wire shall be wrapped around a ¾ inch PVC pipe 10 times at all splices.

Wire color code shall be white for common, red for trees, green for shrubs or ground cover and blue for other components, as designated. The plans will have a wire schedule to show the minimum wire gauge to be installed on the project. Wire sizes shall be a minimum of 14 gauge and as specified in the project plans.

The Inspector shall do a visual inspection to verify that the wire being installed is in accordance with the project plans and Special Provisions. The wire size and type will be continuously written on the jacketing of the wire.

Electrical splices shall be permitted only in valve and junction boxes, or at the control equipment. No direct burial splices shall be allowed. The types of electrical splices allowed in ADOT irrigation projects shall be as specified or approved for use by the Resident Engineer. The Inspector will need to investigate what has been submitted and approved by the Resident Engineer and read the installation procedures for that style of connector.

The mainline should be installed up to the ball valve in front of the remote control valve. The flushing ball valves should be opened. The Contractor should close them, as water starts to flow from the ball valve, starting at the closest source and moving towards the end of the line. Test the mainline and then install the remote control valves and sub-main lines.

The sub-main should be installed up to, but not including, the pressure regulators. As water begins to flow from the regulator riser, it should be capped, starting with the closest emitter to the source, moving towards the end of the sub-main. Test with ball valves closed. After testing, remove the caps and install the pressure regulators and laterals.

The lateral pipe should be installed up to, but not including, the emission device. The process begins by flushing the lateral with the supply tubing open. As water begins to flow from the tubing, it folds over and becomes kinked or closed. A retainer, installed on the end working closest to the source, forces all of the debris out the end of the line. Test and install the emitters.

Install thrust blocks and partially backfill, leaving all joints and fittings exposed, prior to testing pipe. Under no circumstances will air be acceptable as a testing medium.

The Inspector is responsible for collecting a copy of the Backflow Prevention Unit (BPU) report after the testing has been completed. A copy is placed in the project files after being reviewed by a supervisor. A copy is also made available for the appropriate municipal representative, if requested. It is recommended that the Inspector keep a copy on site for their records to identify project information (like BPU type, model, address, locations, serial numbers, sizes and owners/purveyors) for BPU water meters.

The Contractor's certified tester should always check a BPU assembly that appears to be leaking.

The Contractor should not be allowed to use water from a source without first having an approved backflow prevention device installed and tested. BPU units installed on ADOT and/or city irrigation systems must be installed according to municipal regulations or Maricopa Association of Governments (MAG) standards.

The Inspector should check for leaking sweat joints on the copper fittings, threaded pipe connections, minimum clearances (12 inches above grade) and placement (close proximity to the water meter) requirements according to the standards.

All irrigation system components and piping shall be tested for acceptance. All emitter lateral lines shall be tested at the operating flow pressure. Document the testing on the Irrigation System Pressure Test form and reference in the Inspector's Daily Diary.

The Inspector should check all isolation valves in the section being tested to ensure that they are all open. All remote control valves should be assembled and installed prior to testing.

The pipe shall be pumped up to the pressure called for in the Special Provisions or Standard Specifications. The gauge should be monitored for the first 15 to 30 minutes to see if the pressure holds. If the pressure begins to drop, the Inspector should walk the tested portion of pipe looking for visual signs of leaks. If the pressure holds, the Inspector should stay at the test site for the duration of the test to verify results.

If leaks are discovered, they must be repaired. The Contractor is then required to retest that portion of pipe. The test should be administered until it passes. Air trapped in the pipe can cause the pressure test to fail. It is important to remove all of the air out of the lines before testing. Not being able to locate leaks does not excuse the inability to pass the pressure test. The Contractor is responsible for passing the test. It is unacceptable to pump the pressure higher than the required pressure in the contract documents so that the specified pressure is reached after the duration.

All portions of the mainline shall be partially backfilled, leaving all fittings exposed and thoroughly flushed of all foreign material prior to installation of any remote control valves or irrigation devices. All portions of the sub-main shall be backfilled and thoroughly flushed of all foreign material prior to installation of any pressure regulators or irrigation devices. Laterals should also be flushed before any emission devices are installed.

After the system has been installed and is operational, the blow out filters and flush end caps should be opened. Allow the system to run for 2 to 3 minute intervals for flushing, during both construction and landscape establishment.

The flushing of valves, piping and other components shall be performed in accordance with the Special Provisions. The minimum velocity of 4 feet per second flushing, must be verified by a meter at point of connection or, in some cases, at the flow meter by the backflow assembly.

In the following tables, please note that the gallons per minute (GPM) at the meter will read differently for different velocity and pipe sizes.

Flow in GPM for Schedule 40 PVC

Velocity Ft/s	½”	¾”	1”	1 ¼”	1 ½”	2”	2 ½”	3”	4”
1	0.9	1.6	2.6	4.5	6.2	10.3	14.6	22.7	39.1
2	1.8	3.2	5.2	9.1	12.4	20.5	29.3	45.3	78.3
3	2.7	4.7	7.8	13.6	18.6	30.8	43.9	68.0	117.4
4	3.5	6.3	10.4	18.1	24.8	41.0	58.5	90.6	156.5
5	4.4	7.9	13.0	22.6	30.9	51.3	73.2	113.3	195.6

Flow in GPM for SDR21 Class 200 PVC

Velocity Ft/s	½”	¾”	1”	1 ¼”	1 ½”	2”	2 ½”	3”	4”
1	1.2	2.0	3.3	5.4	7.1	11.1	16.3	24.2	40.1
2	2.4	4.1	6.7	10.8	14.1	22.2	32.6	48.5	80.1
3	3.6	6.1	10.0	16.1	21.2	33.3	48.9	72.7	120.2
4	4.7	8.1	13.4	21.5	28.3	44.4	65.2	96.9	160.3
5	5.9	10.1	16.7	26.9	35.4	55.5	81.5	121.1	200.4

½ inch PVC pipe is not manufactured in Class 200. However, it is available in Class 315.

After flushing the system, all irrigation devices shall be assembled and installed. They will require settings at the proper elevations according to the Project Plans. Final adjustments, after the finish grade is established, must be inspected. A visual inspection of the clearance of both horizontal and vertical items installed in valve boxes should be performed.

Bubbler and sprinkler devices are assembled using threaded PVC connections. The tubing used is either polyethylene supply or vinyl distribution tubing. Polyethylene tubing connects from the PVC to the emitter. Vinyl distribution tubing connects from the emitter to the emission point at the base of the plant or as shown on the plan details. The tubing is flexible and must be handled with care.

Supply tubing should be used to center the emitter in the group of plants it will be serving. With trees, bring the emitter to within 5 feet of the base of the tree or as detailed on the Project Plans.

The emitter systems distribution tubes are held in place with hose stakes. It is important that they are placed as shown on the Project Plans. Their placement around the plant determines the wetting pattern. Emission points work together to push salt away from the root zone and supply the plant with fresh water. In sloped conditions, the emitter and emission points shall be placed on the uphill side of the plant because gravity will pull the water downhill. When a plant requires more than one emission point, one point will be placed at the root ball. The remaining shall be distributed around the plant as detailed on the Project Plans.

Future emission points shall be placed and plugged at radius distance as detailed and approved by the Landscape Architect. All emission points shall be installed at time of construction and opened (unplugged) during the landscaping establishment period as required. During landscaping establishment the root ball emission point will be adjusted as directed by the Resident Engineer.

The number of outlets each individual plant receives will be indicated on the project plans in an Emitter Schedule. The Emitter Schedule is a table that identifies the emitter type, placement, outlet GPH, recommended run hours and number of tubes open at construction and maturity.

Emitter Schedule Defined

Emitter Placement	coordinates with another detail outlining where the distribution outlets will be placed around the plant material.
Emitter Type	identifies whether the emitter will be a single or multi-outlet unit.
Tubes / Emitters at Construction	number of tubes opened at the beginning of construction.
Tubes / Emitters at Establishment	number of tubes opened during landscape establishment
Outlet GPH	nominal gallons per hour each emission point will produce
Peak Run Hours	hours the designer believes the plant material will need in a worst case scenario. The hours shown in the schedule are for reference only. *Note: It should be noted that the ultimate decision on how much water the plant material receives is up to the Contractor.*
Peak Daily Gallons	amount of water applied to each type of plant material at the peak run hours applied. This is equal to the following: Tubes open x outlet GPH x runs hrs = Daily gallons 4 x .6 x 5 = 12
Peak Daily Applied Inches	inches applied during each watering cycle
Plant Names	name of the plant material to be watered.

Exhibit 808-3.03-1. Emitter Schedule Defined

Emitter Schedule

	EMITTER PLACEMENT See Emitter Placement for detail	EMITTER TYPE M=Multi S=Single	TUBES/EMITTERS @ CONSTRUCTION	TUBES/EMITTERS @ ESTABLISHMENT	OUTLET GPH	PEAK RUN HOURS	PEAK DAILY GALS	PEAK DAILY APPL'D INCH SYMBOLS	PLANT NAMES
Trees	C	M	4	4	0.6	5	12	0.04	SWEET ACADIA
	A	M	10	10	0.6	5	30	0.07	BLUE PALO VERDE
	A	M	10	10	0.6	5	30	0.07	LITTLE LEAF PALO VERDE
	A	M	10	10	0.6	5	30	0.07	MEXICAN REDBUD
	A	M	10	10	0.6	5	30	0.10	DESERT IRONWOOD
	C	M	4	4	0.6	5	12	0.06	TEXAS EBONY
	A	M	10	10	1.0	5	50	0.08	HONEY MESQUITE
	A	M	10	10	1.0	5	50	0.08	ARIZONA MESQUITE
	C	M	4	4	0.6	5	12	0.11	CHASTE TREE
	C	M	4	4	0.6	5	12	0.11	ARIZONA YELLOW BELL
	C	M	6	6	1.0	5	30	0.10	DATE PALM
	C	M	6	6	1.0	5	30	0.15	WASHINGTON FAN PALM
Shrubs	B	M	3	3	0.6	1	1.8	0.05	BARBARA KARST
	B	M	5	5	0.6	1	3.0	0.10	RED BIRD OF PARADISE
	B	M	5	5	0.6	1	3.0	0.10	LITTLE LEAF CORDIA
	E	M	1	1	0.6	1	0.6	0.03	DESERT SPOON
	E	M	1	1	0.6	1	0.6	0.01	OCOTILLO
	E	M	1	1	0.6	1	0.6	0.05	RED YUCCA
	B	M	2	2	0.6	1	1.2	0.15	DESERT RUELLIA
	B	M	2	2	0.6	1	1.2	0.04	JOJOBA
	E	M	1	1	0.6	1	0.6	0.05	SIERRA GOLD
	E	M	1	1	0.6	1	0.6	0.03	TRAILING INDIGO BUSH
	E	M	1	1	0.6	1	0.6	0.14	DESERT MARIGOLD

Not all emitter schedules are identical but information contained in the schedule should be consistent from one to another.

Bubbler systems are utilized on level ground and rely on a basin or contained bed area that is flooded when the valve is opened. Construction of the finish grade elevation is critical to ensure adequate dispersal and containment of the applied water. With poorly constructed basins, water may spill into the roadways. They can also create erosion rills when installed on any kind of slope.

Careful attention should be given to the basin construction, especially where decomposed granite is applied over the finish grade. Do not allow the granite to be spread until the basins or swales are inspected and approved. The wetting pattern and salt leaching capabilities are as critical as they are for emitter systems.

The Electrical Inspector is responsible for the inspection of power and source connections to the controller. The Landscape Inspector is primarily responsible for the inspection layout, location and the controller components. The controller cabinet layout and location, relative to other irrigation components, must be approved prior to installation of the concrete slab. The Contractor should give the Inspector a 24-hour notice so that inspections can be done for the following:

- quantity, size and location of conduit sweeps, sleeves
- concrete pad dimensions and thickness, reinforcements, turndowns
- setting controller cabinet
- NEMA supports (National Electrical Manufacturers Association)
- adjacent grade relative to the pad
- mixed design
- coloring to differentiate between the common, spare, tree and shrub wires
- concrete curing compound
- ground rods

The wires should be bundled and routed through the cabinet in a clean, organized manner resembling the project details.

The Inspector is responsible for obtaining from the Contractor, a wire diagram or schematic of all controller components. A copy should be added to as-builts and kept inside the controller cabinet for reference prior to the close of construction.

The Inspector is responsible for obtaining a copy of the irrigation controller program schedule from the Contractor. A copy is provided to the supervisor for placement in the file. The program or schedule is compared against the project plans and is used for calculating water usage reports.

The ADOT controller, when it is a Motorola, communicates via radio. The correct type and quantity of radios should be checked by the Inspector. Communication should be verified in the field between controllers (Field IRRinet Units) and their sub-satellite controllers (Scorpio Units), if applicable, and the home base (Central Command Center). The Inspector is responsible for the coordination and assignment of the correct radio ID addresses with the ADOT supervisor and the Contractor.

The Inspector is also responsible for monitoring the radio communication periodically during construction and establishment. The radio address must be programmed into the controller using an approved address supplied by ADOT. The radio communication controller program can be verified at the Central Command Center computer located either at district maintenance or district construction offices (Phoenix and Tucson districts only). The controller should be programmed in flow.

The irrigation system controller must operate all the automatic or remote control valves (RCV) electronically according to the programmed instructions. Instructions are input by a field programmer. The Inspector should verify accurate operation by having the Contractor run the program from the controller and verify that each remote control valve opens and closes accordingly.

The verification of the operation of the controller is recorded on the Irrigation System Pressure Testing Report. If no pressure is recorded, or the remote control valve does not turn on, the Contractor must resolve the deficiency before the Inspector accepts the work. Once the repair has been made, the inspection procedure is repeated.

The Inspector should verify that the master valves open and close according to the program for each valve grouping. The Inspector should follow an ADOT supplied inspection punchlist for the controller items that include:

- Flow monitoring system
- Microphone is included
- Spare wires color/quantity
- Connection to terminal board
- GFI receptacle is included
- Proper grounding
- Pressure switch set
- Master valve connection

Unless otherwise specified, all irrigation systems within the designated controller area shall be completed, tested, approved and properly backfilled before landscaping can begin.

The system should be set to pre-water the plant pits prior to planting. In +100° F temperatures and dry soil, it is not uncommon for newly planted specimens to wilt and expire in a few hours.

The operation of the system and the amount of water needed by each plant will vary. There are no set watering times, although guidelines exist to help the designer calculate the daily demand for plants in a landscape project. The information is based on mature plant size, type, evapotransporation (ET), irrigation efficiency, and soil type. The information available in the field is by direct observations of the plant and soil. If plants are wilting, water is needed. Check by probing the soil. Generally grasses and flowers need watering to a minimum depth of 12 inches, shrubs to 2 feet and trees to 3 feet or more.

Freeze protection must be provided as specified in the project documents. Either a three-way valve (with compressed air fitting for blowing water out of the lines) or automatic drain valves, placed at the low point of each lateral pipe, must be used. The type of drain and installation shall be as specified and detailed in the project documents.

To keep the system in good working condition during landscaping establishment, the gate valves should be opened and closed to ensure proper operation. Filter and end caps should be checked and flushed. Pressure and flows should be verified. (See the monthly irrigation inspection form).

Serving Utility

Water Source

Irrigation water can be supplied through a number of sources. It can be delivered from a temporary water storage tank, from city water or from a private water supplier. The water source for any project will be identified within the Project Plans and Special Provisions. A project located within an urban or rural setting will have irrigation water supplied from an underground water mainline of various sizes. Projects located outside of an urban setting will have water delivered by a water truck to above ground temporary water storage tanks.

When the water source is a city or private water purveyor, a water meter is installed so that the amount of water used on a project can be determined and the appropriate billings processed. Water provided at the water source and through the water meter is generally used only for planting, landscaping establishment, irrigation line flushing, and irrigation equipment testing. The water provided through the water meter must not be used for office equipment, construction yard, water-settling trenches, watering in pre-emergent herbicide, rock or granite mulch or other construction related tasks.

The Contractor shall be responsible for contacting a representative of the water department, requesting the water service and arranging for installation. Before any water can be used from any source, the Inspector must ensure that the local water provider has inspected and accepted the connection to the infrastructure. This should be documented in the Inspector's diary.

The Contractor shall work with the city and Inspectors on the exact location of the water meter. All coordination, meetings, permits and miscellaneous work related to establishing the exact location(s) for the water meter(s) shall be completed by the Contractor.

The cost and work performed by the Contractor for the installation of the water meters shall be at no cost to the department. The cost will be considered as included in the item providing water service or related items. The Contractor will be reimbursed for any work performed by the city. Upon billing, the Contractor shall pay the city for the cost of water service installation and will be reimbursed for the exact amount paid to the city. This may vary according to intergovernmental agreements. No supplemental markup will be allowed. The work for providing water service will be paid for as stated in the Special Provisions.

The Contractor should contact the city for water meter installation before the pre-construction conference. Actual dates of installation shall be set at the Pre-construction Conference. Contractor shall coordinate with the city regarding any water services work completed under the roadway contract.

The water meters must be placed in ADOT's and the city's name in the Phoenix area. In areas outside of Phoenix, the water will be placed under that city's name. Usually city supplied water is paid through a municipality.

The Contractor should measure the static water pressure on site at each point of connection as soon as practical and report to the Inspector. This is done to ensure that the pressure is the same or higher than the design pressure shown on the plans. If the pressure is too low, contact the supervisor or designer to determine if modifications are necessary.

The Inspector should be aware of the water purveyor supplying the project with reclaimed water. When reclaimed water is supplied to a project it is necessary to work a specific set of rules.

The Inspector must ensure that the Contractor prepares worker education and safety guidelines detailing the risks associated with and working with reclaimed water.

The Contractor shall be responsible for keeping all reclaimed water out of contact with the general public. At no time shall the reclaimed water be allowed to escape onto the roadway or into any drainage systems.
Color identification shall be purple and shall be integral with the valve box and pipe manufacturing process. All valve boxes, lids, remote control valves, and PVC piping shall have the color purple for identification of a non-potable system. Any PVC pipe shall meet the provisions for identification as set forth by the Arizona State Department of Environmental Quality for the use of Reclaimed Water

The Contractor shall comply with all laws, from all appropriate jurisdictions, that pertain to the construction, operation, and maintenance of reclaimed water distribution systems during construction and during the establishment period.

The irrigation system will be operated to avoid ponding or puddling. To minimize ponding or runoff, the reclaimed water shall be applied at a rate that does not exceed the infiltration rate of the soil.

Signs reading “CAUTION: RECLAIMED WATER, DO NOT DRINK” shall be prominently displayed on the roadway and at all entrances to the roadway. It is particularly important to place the caution signs around any aboveground irrigation equipment. The purpose and intent of properly notifying the public is to ensure that the reclaimed water is not misused.

All reclaimed water system facilities shall be identified by the color code and marking system specified by the Maricopa Association of Governments, revisions 1998 through 2003 (MAG Section 616), to differentiate it from the potable water system.

There shall be no connection between the potable water supply and any piping containing reclaimed water.

People working in and about the reuse site shall be informed that reclaimed water is being used and shall take appropriate safety precautions.

Reclaimed water irrigation systems are subject to restrictions in construction that Contractors shall make themselves aware of. The Contractor will comply with all Municipal, County, and State codes regarding construction of the reclaimed water irrigation distribution systems. Special attention must be paid to worker safety, hygiene, training and the required separation distances between any reclaimed water line and any potable water line.

The Contractor will not be paid extra for installing this irrigation water distribution system in complete compliance with the rules and restrictions of Local, Municipal, County, or State, in place at the time of the construction.

Electrical Source

The local electrical company usually provides an electrical source for the irrigation system. The project designer will have completed coordination and identification of the electrical source during the development of the construction documents.

The Contractor shall work with the utility company and Inspector on the exact location of the electrical point of connection(s) (POC). All coordination, meetings, permits, and miscellaneous work related to establishing the exact locations for the point of connections, shall be completed by the Contractor. The costs and work performed by the Contractor for the installation of the electrical service(s) shall be paid for as stated in the Special Provisions.

The amount and type of work requiring completion by the Contractor will be detailed on the project plans as stated in the Special Provisions.

The Inspector shall be responsible for contacting an ADOT electrical Inspector and confirming that a clearance letter has been received. The letter must state that the installation of all electrical items conforms to the local utility company requirements. After all permits and fees have been paid according to the Special Provisions, the utility company will install the electrical meter and make the final electrical connection. Electrical services need to be placed in ADOT's name

808-4 Method of Measurement

Items should be measured or counted as called out on the cost estimate. The choices for irrigation measurement are lump sum (L. SUM), each (EACH), or linear foot (L.FT.).

Measurement for each include emitters, pressure regulators, control valves and controllers, while pipe and tubing is measured by the linear foot. It is important for Inspectors to read and understand the Special Provisions. This will help identify items that require measuring. In most instances the distribution and supply tubing are considered part of the emitter cost.

The Inspector will consider measuring the pipe while the pressure test is being conducted. The trenches should be walked to look for leaks and can be measured by the wheel at the same time.

While the Method of Measurement in the Special Provisions explains how the individual items are to be paid, the Description, Materials and Construction Requirements sections explain what is involved in the individual pay item.

GLOSSARY OF WATER DISTRIBUTION TECHNOLOGY

Air Release Valve
A device used to expel air in the piping system.

Anti-Siphon Device
A device used to assure positive protection against back-siphonage of impure water into main supply in the event that pressure loss causes vacuum conditions.

Application Rate
The rate (inches or gallons) at which water is applied to the turf or landscape. In sprinkler irrigation, refers to the amount of water applied to a given area in one hour, usually measured in inches/hour.

Approved Backflow Prevention Device
A device, method or type of construction that has been approved by an appropriate regulatory agency that will prevent backflow into the potable water system.

Arc
The degrees of coverage of a sprinkler from one side of the throw to the other. A 90-degree arc would be a quarter of a circle coverage. Likewise a 180-degree arc would be identified as a half circle coverage.

As-Built-Plan
A complete plan of an installed irrigation system that designates the valve, sprinkler, controller locations, routing of pipe and control wire. The plan includes all changes to the original design necessitated during the systems installation.

Atmospheric Vacuum Breaker
A mechanical device consisting of a check valve in a supply line, where the valve member opens to the atmosphere when the pressure in the line drops to atmospheric levels or below. An atmospheric vacuum breaker is designed to prevent back-siphon age only. It is not effective against back-flow due to backpressure and should be installed only on the downstream of the control valve.

Automatic Control Valve
A valve in an irrigation system that is activated by an automatic controller through the use of electrical control wire. Also referred to as a remote control valve.

Automatic System
An irrigation system that will irrigate in accordance to a preset program.

Available Water
That amount of water held in the plant root zone between field capacity and the wilting point.

Backflow
The reversal of flow or a mixture of water and other undesirable substances into the distribution piping of the potable water system. There are two types of backflow, backpressure and back-siphonage.

Backflow Preventer
A mechanical device that prevents the reverse flow of any foreign liquid gas or substance from a non-potable system into a potable water system.

1. Vacuum Breaker
    a. Atmospheric Vacuum Breaker
    b. Combination Atmospheric Vacuum Breaker and Control Valve
    c. Pressure Vacuum Breaker
    d. Hose Connection Vacuum Breaker
2. Double Check Valve Assembly
3. Reduced Pressure Backflow Preventer

The choice of backflow preventer to be used will depend on the degree of hazard and the particular piping arrangement involved.

Backpressure
Any condition that could cause the non-potable water system piping pressure to be greater than that of the potable water system. This allows the non-potable water to be pushed back into the potable water system, most likely caused by gravity due to elevation changes or booster pumps.

Back-siphon age
A form of backflow due to a negative pressure within a potable water system. This is most likely caused by a fire engine connecting to a fire hydrant and pumping water to put out a fire or supply line breaks.

Booster
A pump that has a pressurized suction and is designed to raise the existing pressure of the water in the irrigation main line to a desired level.

Bug Screen or Cap
A device placed at the end of the emitter distribution tubing or emitter head to prevent dirt and insects from entering and plugging the line.

Check Valve
A valve that permits water to flow in only one direction.

Circuit
A group of irrigation devices controlled by one valve.

Combination Atmospheric Vacuum Breaker
A combination atmospheric vacuum breaker and irrigation control valve is a device that combines in one body an AVB and a tightly closing shut-off valve located upstream of the vacuum breaker portion.

Controller
A mechanical or electronic timing device and enclosure. The enclosure shall be capable of automatically actuating automatic remote control valves or other devices on a preset program.

Coverage
General term referring to the manner in which water is applied to the spacing between sprinklers.

Cross Connection
A connection between the pipe transporting potable water and the pipe that is transporting non-potable water that creates a point where a polluting substance may come in contact with the potable water.

Distributing Tubing
A flexible plastic tube, polyethylene or vinyl connected to the emitter for the purpose of delivering water to the plant at a specified location.

Double Check Valve Assembly
Generally refers to a type of backflow preventer that is composed of two inline positive seating check valves. The DC assembly also includes two approved shut-off valves and test cocks.

Drain Valve
An automatic or manual valve located at a low point in the irrigation system, which allows the system or portions thereof to be drained during winterization of the system.

Electric Valve
Automatic valve usually controlled by 24 to 30 volt current. These are connected with wire to the controlling device or circuit.

Emitter
A precise metering device capable of very low flow rates for the slow application of water and nutrients directly to the plant material. Emitters are generally installed adjacent to the plant material to be watered. Additional water application points may be located, as required by project documents, by using distribution tubes from the emitter.

Evapotransporation
Evapotransporation transfers water from soil to the atmosphere. It is the total amount of soil water lost by transpiration through plants and by evaporation from the soil surface.

Fertilizer Injector
A mechanical device for the proportional injection of nutrients or chemicals into the irrigation system. The injection device shall be electrically or water operated and adjustable to the injection rates.

Filter
A mechanical device for the removal of harmful materials that would plug orifices or nozzles of irrigation equipment. The filter shall consist of a body or vessel containing a porous filter element with openings compatible with filtration requirements of the irrigation equipment.

Flow Control Valve
A valve that regulates the flow rate of water without drastically altering the pressure.

Flow Switch
A device placed in a piping system to monitor water flows. May be used to start or stop pumps or other devices as required by system design.

Friction Loss
The loss of pressure caused by water flowing in a pipe system. Pressure loss is due to turbulence produced by water flow against the inside wall of the pipe. Friction loss is a function of the pipe inside diameter, wall surface roughness and the velocity of the water flow.

Gravity Flow
Flow of water in a pipe on a descending path.

Ground Water
Water found below the surface and usually considered not to include the water flowing in underground streams.

Gypsum
A widely distributed mineral consisting of hydrous calcium sulfate that is used as a soil amendment to counteract alkali conditions.

Head of Feet
A measure of pressure in feet of water. Equivalent to .43 psi per foot of water depth or 1 psi per 2.1 foot of vertical rise.

Head-to-Head Spacing
The placing of sprinklers such that a sprinkler radius of throw causes water to hit adjacent sprinkler heads. Also know as 100% coverage and head-to-head coverage.

Hose Connection Vacuum Breaker
A device consisting of a positive seating check valve and an atmospheric vent that is biased to a normally open position. The device is designed specifically for use on hose threaded outlets.

Impact Drive
A method of providing rotational movement to a sprinkler through the use of a weighted or spring loaded arm. The arm is being pushed away from the sprinkler by the water stream and returning impact with the sprinkler body to force a movement.

Infiltration Rate
The rate at which the soil will take in water, measured in inches per hour.

Irrigation Frequency
The amount of time that can be allowed between irrigation cycles to avoid runoff.

Lateral
The low-pressure piping downstream of the control valve where the water delivery devices are located. Laterals may be flexible or rigid plastic material as required by project documents.

Leaching
The removal of harmful soluble salts from the plant root zone by an extra heavy application of water; the undesirable salts are carried by gravitational water to a point below or out of the root zone.

Loop
A piping network that allows more than one path for water to flow from the supply to the point(s) of demand.

Mainline
A large pipe that is sized to carry the water for the irrigation system. Mainline is the piping between the supply point of the backflow device and the control valve and is under pressure at all times, unless drained during the winter or turned off by the master valve.

Manual System
A system in which control valves are opened manually rather than by automatic controls.

Master Valve
A valve located at the supply point of the mainline that opens or closes by commands from the controller.

Moisture Control
An automatic feature on the control equipment that will control the programmed cycles based on the moisture content of the soil in the area of the moisture sensor.

Moisture Sensor
A device that senses the moisture content of the soil at a predetermined depth. The device may be equipped with a gauge for visual observation or may be capable of automatically controlling the irrigation cycle(s).

Normally Closed Valve
An automatic valve that allows no water to flow unless externally activated by remote forces.

Normally Opened Valve
An automatic valve that allows water to flow unless externally activated by remote forces.

Operating Pressure
The pressure that allows a system of irrigation devices to operate. Operating pressure is static pressure less pressure losses. Usually indicated at the base or nozzle of the irrigation device.

Orifices
Openings in pipe, tubing and nozzles.

Overlap
The coincidence of coverage by more than one sprinkler in a common area. The amount of overlap is expressed as a percentage of the radiuses or spacing of the sprinklers.

Peak Consumptive Use
The average daily rate at which moisture is used during the growing season, when evaptransporation is at the highest level. Peak consumptive use may be expressed in inches of water per day.

Peak Moisture Demand
The amount of moisture required by a plant during its peak maximum growth, which usually occurs during the time when temperatures are at a maximum transporation and evaporation are generally at their highest levels.

Percolation
The downward movement of water through soil.

Permeability
The quality of soil that permits water and air to be moved through it.

Pollution
The presence of a foreign substance that creates, or may create, a danger to the health and well being of the general public.

Polyethylene Pipe
A black flexible pipe or tubing commonly used in emitter systems. Polyethylene pipe is manufactured with controlled inside and outside dimensions.

Polyvinyl Chloride PVC Pipe
Unplasticized polyvinyl chloride pipe. A semi-rigid plastic in general use in irrigation systems that is available in a variety of thicknesses and pressure ratings. PVC pipe is manufactured with controlled inside and outside dimensions.

Potable Water
Water that is safe for drinking, cooking or personal use.

Precipitation Rate
The rate at which sprinklers apply water to the landscape. Usually figured for a pattern at a given spacing. The precipitation rate is expressed in inches/hour.

Pressure Regulator
A device that regulates the available pressure to a preset maximum. May be used to protect the piping system from excessive pressures or for reducing operating pressures to individual or circuited irrigation devices.

Pressure Relief Valve
A valve that will open when the pressure exceeds a preset limit (to relieve and reduce the pressure).

Pressure Vacuum Breaker
A device contained within a single body, consisting of a single loaded check valve and a loaded air-opening valve, that opens to admit air whenever the pressure within the body of the device approaches atmospheric pressure. The body of the device shall be equipped with two (2) tight closing shut-off valves and test cocks for appropriate testing. The unit is designed to prevent back-siphon age only and is not effective against backflow due to backpressure. Pressure vacuum breakers shall be installed a minimum of 12 inches above the highest water in the system.

Primer
Used to soften the surfaces of PVC and CPVC pipe and fittings that is necessary for the proper solvent welding of the materials.

Programming
The act of devising and applying to the controllers a plan or procedure for irrigating landscaping material. A program consists of a day to water, a start and watering time, quantity (flow) and what control valves should irrigate.

Pump Start Circuit
The features on some automatic controllers allow a connection to be made through a relay with the pump starter so that the starter will be energized when the watering cycle begins.

Quick Coupling System
An irrigation system that uses quick coupling valves and coupling keys. The valves are permanently installed, while the keys and attachments are manually moved from valve to valve.

Rain Shutdown Sensor
A mechanism that will stop or delay the watering program when a preset amount of rain falls.

Rate of Application
The rate that water is applied to the ground by the sprinklers within a pattern, sometimes referred to as the precipitation rate.

Reclaimed Water
Wastewater that has been treated and brought to a level of water quality that makes it suitable for further beneficial use. It is used for turf and landscape irrigation, recharge, and suitable for some industrial uses such as cooling towers.

Reduced Pressure Backflow Preventer
A device consisting of two (2) positive seating check valves and an automatic operating pressure differential relief valve, integrally located between the two check valves. It is installed as a unit between two tightly closing shut-off valves, and fitted with properly located test cocks. This device is effective against backflow caused by backpressure and back-siphon age and is used to protect the water system from substances which are hazardous to health (high hazard).

Remote Control Valve
An automatic valve that is activated by an automatic controller or manual remote control unit through use of hydraulic or electric control lines.

Repeat Cycle
The programming of an automatic controller to repeat an irrigation cycle automatically for those controller stations so set.

Riser
Usually refers to a length of pipe affixed to a lateral line, or sub-main for the purpose of supporting a valve, emitter, bubbler, or a sprinkler head.

Run-Off
Water that is not absorbed by the soil to which it is applied. Run-off occurs when water is applied at too great a rate, when there is a severe slope or the application rate exceeds the infiltration rate.

Sand Filter
A device installed in a pipeline to remove sand or silt from water by allowing it to settle out of the flowing stream.

Sleeve
Conduit where water pipe or electrical wire is run through. This provides for added protection and ease in replacing piping or wire when running under paved areas.

Slip Fittings
A fitting that is solvent welded on PVC or ABS pipe.

Soil Compaction
Compression of soil particles that may cause the intake rate of a particular soil to be reduced.

Soil-Moisture Tension
The measure of force that allows water to be held in the soil by adhesion and cohesion. It is expressed in terms of atmospheres against the forces exerted by a plant's root system and evaporative processes.

Solvent
A material that causes a chemical fusing of PVC pipe and fittings so that a permanent bond can be accomplished between the pipe and fittings. Each type of PVC pipe may require different solvent/cements. Refer to the Special Provisions.

Solvent Welding
The act of chemically fusing pipe and fittings together using solvent cement/primer.

Spacing
The distance between irrigation heads.

Sprinkler
A hydraulically operated mechanical device that discharges water through a nozzle(s) or an orifice.

Static Pressure
The pressure psi (pounds per square inch) in a closed system, without any water movement.

Stop-a-Matic-Valve
A spring loaded check valve used beneath a sprinkler to prevent low head drainage of circuit piping through the sprinkler heads. The check valve feature may also be built into the sprinkler device.

Supply Tubing
A polyethylene or PVC tube used to supply water from an emitter lateral to the emitter. Supply tubing size varies with emitter manufacturer, the size being specified on the project document.

Surge
An energy wave in pipe lines caused by sudden opening or closing of valves.

Swing Joint
A threaded or “O” ring fitted connection of pipe and fittings between the mainline or lateral piping and irrigation device that allows movement to be taken up in the flexible joint, rather than as sheer force on the pipe. Also used to raise or lower irrigation devices to a final grade without plumbing changes.

Tapped Coupling
An asbestos cement or metal coupling that has a tapped outlet on the side.

Tensiometers
Devices for measuring the moisture content of the soil that work on the principle that a partial vacuum is created in a closed tube when water moves out through a porous ceramic tip to the surrounding soil; the tension causing the movement of water is measured on a vacuumed gauge.

Tension
Energy used in moving moisture from a soil or exerted soil particles to hold moisture; the higher the moisture content of a soil, the lower the tension and vice versa.

Thrust Block
A concrete support poured adjacent to pipe fittings and valves where surging is expected. It holds the pipe in place and prevents movement that could damage connections. Thrust blocks are normally placed between the fittings and undisturbed soil at the side of a trench.

Transporation
A process in where the plant moves water from the soil throughout the plant to the leaves and transpires moisture to the atmosphere.

Underspaced
The unusual situation where heads are spaced closer than they need to be for efficient operation of the system.

Uniformity of Application
A general term designating how uniform the application of the sprinkler is over the area it is covering.

Vacuum Breaker
A type of backflow prevention device that prevents the reverse flow of water from a potentially contaminated source to the potable water supply, by allowing air to the entire supply line -- interrupting the vacuum or siphon condition.

Vacuum Pump
A type of pump used to move fluids at a low pressure, or to prime larger pumps; operates on the principle of reducing pressure in the direction of the desired movement.

Valve-in-Head
Indicates that the automatic control valve, electric or hydraulic, is an integral part of the sprinkler assembly.
Vinyl Tubing

A flexible pipe used for emitter distribution tubing. It has less potential to coil when exposed to the sun than polyethylene pipe. Vinyl tubing is preferred when laid in place on the surface of the ground.

Water Hammer
A shock wave created by a fast closing valve. Also referred to as a surge pressure.

Water Pressure
Pressure where water exerts are measured in pounds per square inch or in head of feet.

Water Ram
A shock wave set up by introducing water under high pressure into an air filled pipe.