

SUBDIVISION PRESSURIZED IRRIGATION SYSTEMS
FROM AGRICULTURAL WATER

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Introduction

This paper explains how one area in Idaho met the future growth of subdivisions that displaced farm ground by converting agriculture irrigation to pressurized irrigation. It will define some areas of design essential for the successful conversion of agricultural land to subdivided, urban and suburban communities. In Idaho some communities have doubled and tripled in population in the last ten years. Good irrigation designs are needed to accommodate this growth.

The guidelines covered are not all inclusive as the standards are being updated regularly to meet the needs of the communities. An attempt is made to provide the basics to design an adequate system. The presentation follows the process of taking raw land and water rights through to the final completion of the pressurized irrigation system for a typical subdivision. Local codes may supersede some of the principles of design that are presented herein.

Agency Direction

In 1997, the city of Boise, Idaho adopted a pressurized irrigation requirement. The goal was to separate potable water from irrigation water. Ada County cities and irrigation districts followed Boise's lead and adopted essentially the same requirement. Land developers converting agricultural land with surface water rights are required to provide a pressurized irrigation system in subdivisions utilizing irrigation water. The water use of the farmer (full time tenant) contrasts sharply from use of the urban subdivision home owner (part time tenant). When and how water is used is a challenge for the designer of the pressurized irrigation system. Pump graphs for a season of water use give the basis of what the system requirements entail. The graphs show when the water use occurs and the quantity of water use.

Pump type and size are also critical as are the intake screens and the discharge filters. Irrigation districts control the water source which comes from reservoirs of stored water. The larger irrigation districts have their own set of standards and regulations that makes the whole process more complicated.

In a particular area around Boise, Idaho, agriculture land has been the prime target of subdivision development. The farm community has become somewhat aged and the value of the land for subdividing has far exceeded the value for farming. It has given the farmers an avenue for a better retirement and so prime agricultural land has been bought by developers. These land parcels have water rights that typically transfer with the land and that water is by ordinance converted from agricultural use to a pressure irrigation system that delivers water to each subdivision lot.

Land Measurement

The land was historically divided by Township and Range. Township being a measure North and South of an initial point or baseline and Range a measure East and West of a line called a meridian. The unit measure is 6 miles. The boundary formed by a township and range is 6 miles by 6 miles and the total area is 36 square miles. Those 36 square miles are then described by sections 1 through 36; each section being 1 mile square or 640 acres. A section is further divided into quarters, and the quarters then divided into

quarter-quarters, etc. These measurements were generally used for large acreages such as ranches and farms, open range and forests.

There are corrections in some sections to account for variations such as the curvature of the earth and other miscellaneous factors. One section will not always measure one mile, etc.

As cities were formed and continue to be urbanized, land is further divided into lots and blocks and tax numbers. All of the lots and blocks are a part of the sections. Generally all land parcels are filed in a county office in the form of a "land description". The land description is often in the form of a survey using meets and bounds.

The task of an irrigation designer is to determine how much land is going to be irrigated and the most efficient method to apply a sustaining amount of water. One must determine the net amount of irrigated area. This means one must determine the raw land before any buildings, paving or plaza areas are constructed and subtract these features from the raw land to find a net area to be irrigated.

Demand for Water

Water is often allocated to irrigated land. As demand for water increases from industry, recreation, municipalities and agriculture the true value of water is realized. In Idaho right now, several entities are challenging the rights to use the water. Idaho Power, a utility for power, is said to have been able to generate 100% of its power through hydro generators in the past, but at present only half of the company's power is hydro generated. It is important to know that water for a project is secure and will not be taken from a project through some legal wrangling in the future. Even the water-use graphs from one pumping plant have caused agencies to speculate on how much water could be saved and used for other purposes.

In Idaho, water was allocated to the land through districts or legal entities (organizations), which in the early years sorted out the claims to water. Where reservoirs were constructed, owners of land purchased or claimed the stored water in the form of Acre Feet, Shares of water and Miner's inches. These definitions of water were attached to the land and we refer to them as "water rights". You will need to know the equivalent measurements of gallons per minute for each of the ways water volume is expressed. For instance, in Idaho, a miner's inch equals nine gallons per minute. In some of the neighboring states a miner's inch equals 11 gallons per minute. Shares of water vary between districts as shares may equate to different amounts of miner's inches. Some districts allot water solely based on a finite amount in Acre feet per year. Nearly all of these measurements are based on a normal year of precipitation. All of the ensuing calculations in this presentation, where these varying amounts apply, will use Idaho's interpretation of water amounts.

WATER CONVERSION FACTORS

1 cubic foot of water.....	7.4805 gallons.....	62.37 pounds of water
1 cubic foot per second (CFS) ...	448.83 gallons per minute.....	26,930 gallons per hour
1 cubic foot per second (CFS)	646,315 gallons per day...	1.9835 acre-feet per day
1 cubic foot per second.....	for 30 days = 59.502 acre-feet.....	for 1 year = 723.94 acre-feet
1 acre-foot.....	enough water to cover 1 acre of land	one foot deep
1 acre-foot.....	43,560 cubic feet	
1 acre-foot	325,850 gallons	
1 acre-inch	27,154 gallons	
1 cubic meter per second.....	35.31 CFS.....	15,850 gallons per minute
1 million gallons.....	3.0689 acre-feet	
1 million gallons per day (MGD).....	1,120,147 acre-feet per year	
10 cents per 1,000 gallons.....	\$32.59 per acre-foot	
1 miner's inch.....	9 gallons per minute.....	0.02 CFS

From the above table one can further calculate 50 miner's inches equals 1 cubic foot per second (CFS).

With the above background in land and water, a parcel of ground will be broken down to show the process of designing a pressurized irrigation system.

An Example

John Doe owns 80 acres of land. A developer becomes interested in the 80 acres for a subdivision. The developer probably has determined the zoning and density of units he will be able to divide the land into and still profit from the purchase. An agreement is reached between John Doe and the developer and the developer purchases the land and all the appurtenances (including water). Typically the developer will have an engineer/planner draw a preliminary plat showing his intent for the land for approval by the government authorities. This allows the developer to move ahead with the plans knowing if certain conditions are met, final approval for the sale of the lots will be approved.

After the preliminary plat is approved engineering design begins. Roads, common areas, lot lines, water lines, sewer lines, electrical services and/or gas lines, cable, etc. and pressure irrigation lines begin to be designed. Under the standards in Ada County, Idaho a common trench is used for all the utilities other than pressure irrigation. This common trench is located at the road side of the lots and the pressure irrigation line is located at the rear or common lot line.

Pressure irrigation is the subject that will be discussed. After the roads, common areas, commercial lots (if any), and residential lots are delineated, the design for the pressure irrigation system may begin.

Step One involves determining what the *total irrigated ground* will be under the subdivision design.

There are two possible ways to start.

1. Usually a preliminary plat will summarize the amount of land designated to roads, common areas, residential lots and commercial lots. The net amount of ground for building can be taken from these notes.
2. A more laborious method is to determine the gross amount of ground in the property. Subtract the roads by determining the length of the roads and multiplying the width (between the curbs). Subtract the sidewalks by determining the length and multiplying by the width.

Based on the parameters of the subdivision, the square footage of the houses will be stated. Determine the average square footage of the houses and add the garage, driveway, patio, and any other hardscapes that can be determined. Multiply the number of homes or lots in the subdivision to find the area subtracted from the net land of 1. and 2. above. This will yield the net area that will be irrigated.

Depending on the rules of zoning and local density allowances for subdivisions a general finding is the irrigated area is approximately half of the original raw land. A commercial development will have irrigated land of only about one quarter of the original land area.

There are now two more steps or decisions that must be made.

Step 2. What will the water window (time for irrigation) be. Will the project water in 24 hours, 18 hours, or 12 hours?

Step 3. The evapotranspiration (ET) that will be used. One can begin by finding the historical ET from an agency who has those records. The ET should be adjusted for the efficiency of irrigation systems. For example use 60% efficiency. Therefore, it is (for example) .3 (ET at peak season) divided by .6 (sprinkler efficiency) equals .5.

$$\text{GPM} = \frac{\text{Acres} \times 27154 \times .5}{\text{Hours for Irrigation} \times 60}$$

27,154 is obtained from the table above as the number of gallons of water required to cover one acre one inch deep. Sixty is the number of minutes per hour.

Compare the gpm required for the landscaped area to the available flow for the property. If the gpm that is required to be pumped during the watering window exceeds the flow of the water right, a pond or storage amenity must be considered. The total irrigation demand must not exceed the 24-hour water right. This calculation is as follows:

$$\text{Total gallons pumped} = \text{GPM} \times 60 \times \text{Hours in the watering window}$$

Step 4. Compare the total gallons pumped to the water right of the property for a 24-hour flow.

$$\text{Total gallons available} = [(\text{inches})(9 \text{ in Idaho})] \times 60 \times 24 \text{ hours}$$

Also, the result of the gpm calculation will provide the information needed for sizing the pump with the precaution that it is often important to up-size the capacity to 1.25 to 1.4 times the base capacity to account for the peak flows demanded by the irrigation water users (see the Demand Chart).

If there is doubt that the homeowners will adhere to a schedule, it is advisable to adjust the pumping capacity (gpm) to 1.4 times the result of the above equation

If the results from all these calculations show the irrigation requirement exceeds the water right or water available for irrigation, then dryscapes and other landscaping options must be considered to reduce the irrigation requirements.

Step 5. Consideration of the individual lot requirement.

To find the square foot water requirement:

1. Determine the watering window for the lot.
2. Use the same ET and sprinkler efficiency as the calculation for the project.

$$\text{GPM} = \frac{.623 \times \text{Square Feet} \times .5}{\text{Hours (water time)} \times 60}$$

.623 is gallons per square foot = 27,154 gallons divided by 43,560 square feet per acre

The result of this calculation should be reviewed to see if the time of watering or the gpm is practical. The results might be adjusted to find a practical flow (based on a typical irrigation zone). Once this judgment is made, the pump capacity is divided by the lot gpm to determine the number of lots that will irrigate at one time.

$$\text{Irrigated Lots} = \frac{\text{GPM (pump capacity)}}{\text{GPM (lot requirement)}}$$

As a check for the anticipated schedule it is a good practice to divide the total lots by the number of lots that will irrigate at one time. This will yield the number of watering windows in the schedule.

$$\text{Water windows} = \frac{\text{Total number of lots}}{\text{Lots watering at the same time}}$$

An example using the above calculations could proceed as follows:

Given;	A plot of raw land	80 acres
	Water Right	56 miner's inches
	Preliminary plat	4.5 acres the common lots
	Roads	19 acres
	Sidewalks	5 acres
	Minimum Residence footprint	2000 S.F.
	Average lot size	7000 +- S.F.
	Garage size	500 S.F.
	Patio	150 S.F.
	Sidewalk	150 S.F.
	Residential Lots	252

Irrigated Land:

- 80 acres (raw land)
- 19 acres (streets)
- 5 acres (sidewalk)
- 16.2 acres (2000 + 500 + 150 + 150)(252 lots)/43560
- 39.8 net irrigated acres

Step 6. Pump Station capacity

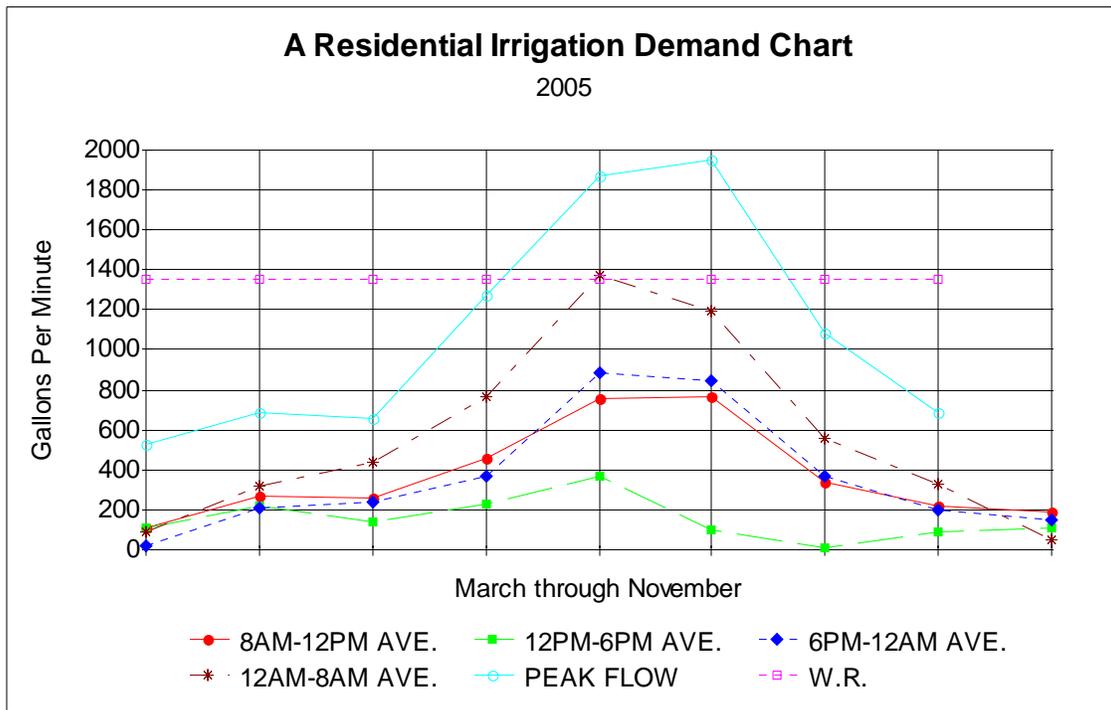
$$750 \text{ gpm} = \frac{(39.8 \text{ acres})(27154)(.5)}{12 \text{ hr. water window} \times 60}$$

$$(750 \text{ gpm})(60 \text{ min/hr})(12 \text{ hr.}) = 540365 \text{ gallons}$$

$$(56 \text{ M.I.})(9 \text{ gpm/m.i.}) = 504 \text{ GPM}$$

$$(56 \text{ M.I.})(9 \text{ gpm/m.i.})(60 \text{ min/hr})(24) = 725760 \text{ gallons}$$

It now becomes evident that some form of storage is the answer to enable 250 gpm +- above the water right flow during the 12 hours of pumping. The above also shows that during the water window less water is used than appropriated during a 24-hour period.



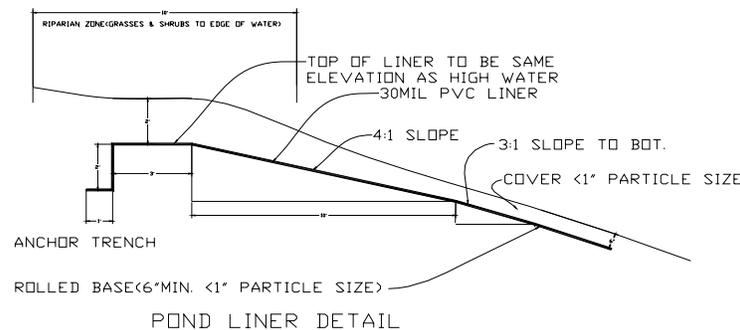
The above chart points out the reason for a storage or pond. Before the subject of constructing a pond is covered it is graphically important to show why that storage is necessary.

Locate the Water Right (W.R.) line on the above chart. It is the Horizontal Line at 1,356 gallons per minute. This is the typical method by which agricultural irrigation water is delivered to a property. Now locate the line representing the irrigation between 12 A.M. – 8 A.M. It varies from March to November. It is a line which indicates the average of water use in that water window. Compare this line to the line above it (Peak Flow) that does not average the flow, but shows what the pump must produce to meet the demand for the period. Comparing these lines will point out that the average line does not exceed the water right but the peak demand exceeds the water right by a factor of 1.4 times. This illustrates some of the basis in the previous example of having a water right of 504 gpm but needing 750 gpm to meet the demand. The deficit of 250 gpm is drawn from the storage or pond.

Pond Construction

In sizing and constructing a pond there are some basic principles to follow.

1. The pond should be safe. Either a fence or some barrier to prevent public access that is acceptable for the area or meets governmental standards.
2. The minimum depth of the pond should be four feet of depth after maximum draw down.
3. A liner is often needed to prevent seepage out of the pond. At least 6 inches of rock-free soil over the liner. This protects the liner from UV rays and prolongs the life of the plastic.



4. Ground water needs to be considered so that it does not float the liner. There are one-way valves on the market.
5. The pond should have a drain or overflow for excess water or in the event that the pump shuts down while water is flowing into the pond.
6. An aeration pump that delivers air to the bottom of the pond and diffuses the air upward to create circulation in the pond.

The deficit of 250 gpm must be reduced to cubic feet in order to know the size of the pond. Therefore:

$$250 \text{ gpm} \times 60 \text{ min per hour} \times 12 \text{ hours} = 180,000 \text{ gallons}$$

180,000 gallon divided by 7.48 gallons per cubic foot = 24,064 cubic feet.

Thus 24,064 square feet x 1 foot deep = 24,064 c.f.

This results in a pond that is 5 feet deep and covers 24,064 s.f. divided by 43,560 s.f. per Acre or .55 of an acre. This calculation is based on the fact that there are 504 gpm available from the water right and 250 gpm of stored water available and the pond will recharge the storage during the other twelve hours of water right.

Alternate to Storage

Advances in technology have created a competitive alternate that is acceptable by some jurisdictions. The technology provides specific times when water is delivered to each lot and is thus able to control the use and spread of water in the system. The engineer can better predict the flows within the system and the water window when homeowners use irrigation water. These systems consist of a Windows-based PC computer, a central control that communicates with remote field units via a two-wire communication system. The remote field units communicate with decoders for remote control valves at the lot services via a two-wire communication line. Landscaping and common areas may be incorporated with the lot service controls. The central computer is capable of communicating with up to 20 remote control units. Each remote unit is capable of communicating with about 120 valves with up to 8 valves operating simultaneously. Generally the remote base units will require 117v single phase power. The central computer can be either a desk top installation or installed within a wall mount cabinet. The computer can plug into a 117 v. single phase service and a standard telephone service. Generally a communication program can be installed for remote control of the system. Some programs come with this capability. The system should be capable of automatically recovering from power failures. Many systems have the capability of verifying the electrical components and maintaining a system operation history. Some systems have mapping capabilities and commands for decoder locations, system status, on/off commands and system adjustments. Flow monitoring features are very useful. Separate programs in the system help various watering strategies including timing for lot watering or fully automated soil moisture controls for landscaped common areas. The computer may be installed in a centrally located clean environment on site.

The Pumping Plant

Step 6. The total horsepower for the pumping plant may be estimated with the following formula:

$$HP = \frac{(\text{head in feet})(Q)}{(\text{efficiency})(3960)} = \frac{750 \times 185}{.7 \times 3960} = 50 \text{ HP}$$

The heart of the system is the pumping plant. It must supply the determined amount of water during the peak demand periods and also during the hours when minimal water is needed. Stations of 4500 gallons per minute must also provide 25 gpm to 50 gpm without cycling on and off. Cycling is detrimental to the piping and fittings because of the potential water hammer and other associated problems. It is therefore important to

specify a pumping plant with the proper equipment to attain suitable performance. Early installations consisted of a simple centrifugal pump with a manual on-off switch box and perhaps a priming apparatus to get the system running. That system is no longer acceptable and more sophisticated pumping plants have replaced or upgraded those early installations.

Some typical requirements of current standards:

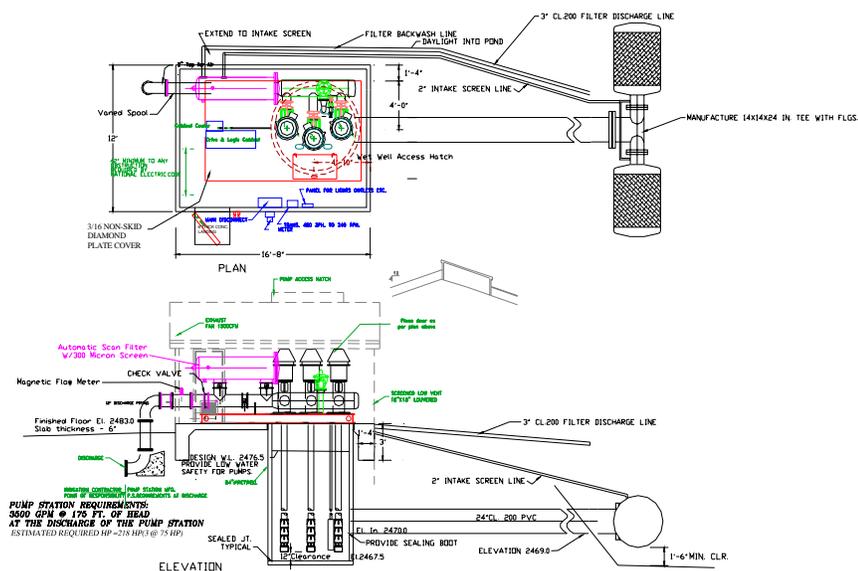
1. A self cleaning, pre-pump screen with suitable screen size to protect the pump from foreign debris. The screen size required by many agencies is 30 mesh (.025 inch) and located in a structure where the overflow will carry the foreign debris into a waste ditch. The screen is often located in a pond with a pipe carrying the screened water to the pump. This pipe should be sized not to exceed a flow velocity of more than one-and-one-half feet per second flow velocity. $V=.408(Q)/d^2$
2. Unless the pump has a flooded suction, a sealed wet well will be designed, which is a structure consisting of a rectangular or cylindrical concrete vessel over which the pump sits. The wet well provides suitable submersion of the pump intake for proper pump performance. Wet wells are typically 48 to 84 inches in diameter and 10 feet deep.
3. Small systems may only require a submersible pump or pumps that sit in the wet well (50 -200 gpm and 50 – 120 psi). Larger systems may justify short coupled vertical turbines. Short coupled vertical turbines generally have a longer operating life than submersibles. Multiple pumps are desirable to a single pump to meet the total flow requirement.
4. The platform or skid on which the pumping plant is built should be a minimum of 10 gauge metal with a substructure of I beams or channel iron. Tubing is generally not allowed as the interior of the tubes cannot be coated with corrosion proofing.
5. A pressure relief valve (PRV) capable of total flow of the pumps should be located on the discharge piping and vented to the wet well.
6. A concrete pad for the pump of suitable size to support the pump and a shelter.
7. A small jockey or pressure maintenance pump (PMP) to maintain pressure in the system that may decrease due to fitting seepage or minimal use. The PMP should not be included to meet the capacity of the pumping system.
8. A post pump filter that removes particles to 200 microns. Automatic filters prove to be economically feasible due to the cost of the equipment and labor for keeping all of the pumping plant filters clean.
9. A reliable meter to record the instantaneous flow in gpm as well as the accumulative flow in gallons or cubic feet.
10. Lightning Protection
11. Low Water Shut-off
12. If a building encloses the pump or pumps, it should exceed the pump mounting skid by 2 feet on each side of the skid. A ventilation fan should exchange the building cubic feet of air every 2 minutes.

Pumping Plant Controls

1. A Main Disconnect to completely isolate all controls and motors from incoming power.
2. Variable Frequency Drive (VFD) or valving to maintain system pressure at various flows.
3. Motor warranties that are not affected by VFD controls.
4. Programmable logic integrated into the VFD controls.
5. Soft start capabilities.
6. Equalized use of the pumps for alternating the lead motor on VFD systems.
7. Pump and motor protection from low water in the wet well or surges through the electrical lines.
8. A remote monitoring feature is a good option.
9. The power utility will often require a filter to prevent harmonic distortions from entering its power grid.
10. Phase failure or unbalance or reversal and overload protection.
11. All controls and panel shall conform to the National Electrical Code.

Pumping Plant Pad

At the top of the wet well and at ground surface, a 6 inch thick concrete pad and collar is placed as a foundation for the pumping plant. The slab shall be of sufficient dimension to accommodate the skid on the pumping plant plus an average of two feet on all four sides of the skid. The slab can have an expanded perimeter footing or a foundation wall for a pump building. The fused disconnect and breakers may be placed on the wall of the building. All NEC (National Electrical Code) electrical clearance codes must be met. The concrete base material under the slab should consist of six inches of one inch minus gravel compacted to 95 percent density. A protective building that meets building codes and the pump manufacturer's requirements for venting and air flow will reduce vandalism and keep ambient temperatures under control.



Lightning Protection

It is advisable to include lightning arresters or other protective devices to be installed per manufacturer's recommendations. Where grounding for the equipment is specified, the contractor should provide verified letters of tests describing and meeting the requirements. A form of insurance that could be checked on is Property Damage Coverage Insurance and Boiler Machinery with comprehensive coverage insurance.

System Piping

Generally standards for golf course irrigation systems may be used. System piping, Pressure Rated PVC 1120, Class 200, SDR 21, Conforming to ASTM D2241, IPS, Gasketed pipe is generally adequate for most systems. Where possible, the mainline should form a looped system. Some jurisdictions require a minimum size of the mainline pipe not less than 4 inches unless a pipe is on a spur lateral. Design flow velocities in the system should not exceed 4.5 feet per second in any section of the system outside the pumping plant.

Deflection in the bell end of the pipe should not exceed manufacturer's recommendation. Fittings of 11^{1/4}⁰, 22^{1/2}⁰, 45⁰, and 90⁰ in the ductile iron fitting line have proven to more reliable than plastic. In order to follow the prescribed alignment or the lot lines as shown on the plans, proper fittings should be used to maintain a uniform offset from the lot lines.

Separation of pressure irrigation piping and potable water lines should conform to governing codes and State Health Department regulations.

Elevation changes within the system should be carefully considered so that the pressure in the system does not exceed 90 psi. If there is no more than a 20% pressure variance in the system, pressure regulators can be used at the individual lot services. Mainline pressure regulators should be used if larger elevation variations occur within the pipe lines.

Secondary Source

A secondary source of water needs to be incorporated into the systems in Northern climates for preseason and postseason system demands. A typical irrigation season for surface water is from April 15 to October 15. The secondary source shall provide adequate flows and pressure for typical evapotranspiration rates for Spring and Fall conditions. A connection to potable water or a well should have an approved backflow device. Cost of the water is usually the responsibility of the Homeowner's Association.

Service Tees

Service Tees should be located uniformly from the lot corner. Piping beyond the Lot Shut Off Valve shall be the owner's responsibility for maintenance.

Warning Post

Most installations require a flat fiberglass stake measuring 3" X 60" driven into the ground or an approved post at the terminal of the service line. A decal placed on the marker stating, "NON POTABLE WATER - DO NOT DRINK" marks the service.

Isolation Valves

Some road standards require isolation valves on each side of a road crossing. The valves often provide adequate isolation within the system. The idea is to be able to shut down sections of a distribution system without interrupting service to other users.

Excavation and Backfill

Standard installation practices for pipe line construction is a good standard to follow. It is prudent never to lay pipe in non-compacted fill. Thrust blocks should be located at all angle changes in the line and at tees and valves. Always back thrust blocks to a vertical native wall of trench. The thrust block should be sized based on the type of material backing it. Thrust blocks should not be placed while the pipe is in an expanded condition in the heat of the day.

Tracing Wire

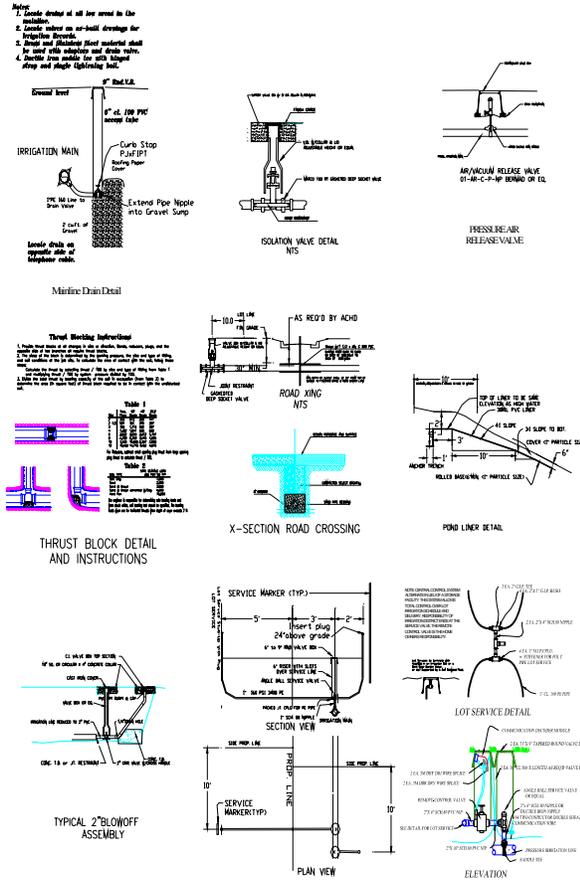
In order to trace the location of the installed mainline, a green #14 single strand copper wire with PVC coating and rated UF may be placed or taped on top of the mainline and terminated or looped into each shut-off valve box so that the entire system can be traced with tracing equipment from the pumping station throughout the piping network. The mainline can also be protected with a purple 2 inch wide warning tape with 1 ½ inch letters indicating a buried irrigation line below. Bury the tape 12 inches below the surface.

Road Crossings

All road crossings, as far as practical should be 90⁰ to the center line of the road. Clearances between potable water lines and other utilities shall be as required by the governing agency. Make sure backfill and compaction meet road crossing standards.

Air Vents

Systems that have elevation variations will require continuous acting air release valves installed at high points in the system or on continuous long runs. Manufacturers recommend that air release valves spaced at a maximum of 1000 feet and sized per recommendations for the size of the pipe being vented.



Exposed Ditch or Similar Crossings

Where the pressurized irrigation mainline is exposed as in crossing a main ditch or canal within the system, mild steel pipe with a pressure rating of 250 psi can be used. Extend the steel two feet inside the point of exposure. Any steel pipe covered with earth or gravel material should be cold tar wrapped or epoxy coated to protect it from corrosion and extend the coating one foot beyond the point of contact with the soil. The steel pipe should have adequate support so that there is no deflection due to the weight of the water flowing in the pipe. Provide a concrete bulkhead on each end of the exposed pipe. If the pipe spans another flowing body of water (a ditch or canal), there should be no contact with the existing flow.

Blowouts

Some jurisdictions require a blowout. At a mid point in the system loop or at the end of laterals, the system may be flushed to a drain ditch or road drainage, a valved discharge pipe that surfaces to atmosphere for the purpose of flushing the line. The vented pipe can be 2 inch and equipped with a removable, threaded cap.

Drains

It is recommended to install drains at low points in the system.

Testing

Pressure testing of the installed piping will prevent future problems. Any immediate shortcomings in the installation will show from a pressure test. Often the knowledge that a pressure test will be conducted will prompt the contractor to a more quality conscious installation.

As-built drawings

As-built drawings are invaluable and should be required in all construction. Rarely are systems installed completely as shown on the plans. Recording these changes is essential.

Warranty

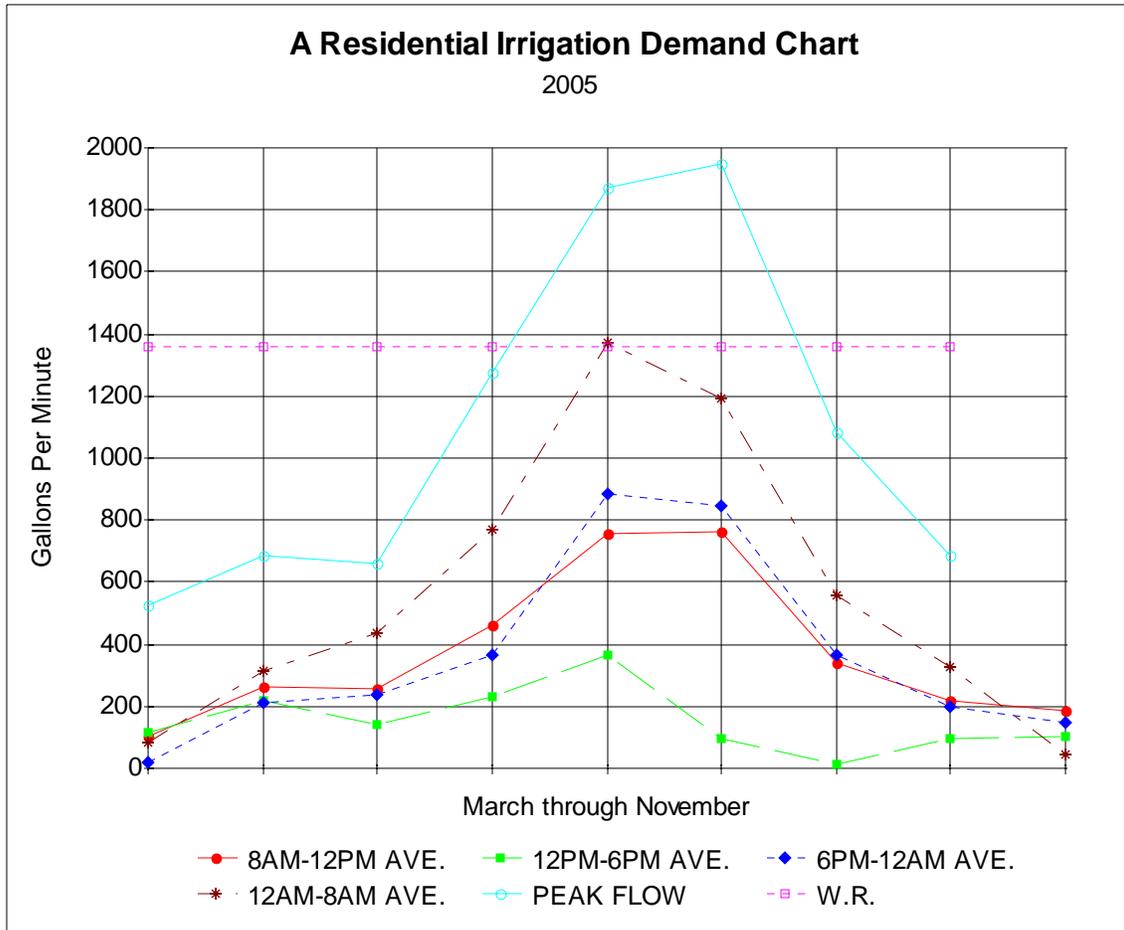
It is a good idea to require that all material, pumping plant components and workmanship be warranted for a minimum of one year from the time Home Owner's Association accepts the operation and maintenance of the system. Some components such as pumps, motors, etc. are warranted more than one year. All warranty cards or contracts for warranty should be handed to the Irrigation District at the time of acceptance. A letter of acceptance should be issued by the entity having jurisdiction over the system. Acceptance should not occur until the contractor can demonstrate full working operation of the system with acceptable tests showing full system parameter flows and adjustments. Motor amperage draw and other tests should be witnessed and recorded to the satisfaction of the controlling entity(ies). An authorized individual qualified to represent the owner may submit a letter to Home Owner's Association verifying he/she witnessed the installation to be in full compliance with the specifications.

Operation and Maintenance Manual

The designer should prepare or require two copies of a manual covering all aspects of the daily operation and upkeep of the system for optimum performance and service. The manual should include cut sheets of the material used in the installation, method of winterization, start up procedures, and local sources of materials used in the installation as well as companies and contacts that can provide services to the entity assuming maintenance of the system.

Water Savings

Now that the system has been constructed and the phases of construction completed. Are there any water savings? In studying the following graph, there appears to be considerable potential water savings.



The area above and left of the peak pump line on the left half of the graph and the area above and right of the peak pump line on the right half of the graph indicate unused water. This constitutes about 25% of the annual water right.

As more technology and control of the water is universally available this unused water may become a valuable commodity to a manufacturing plant or some other entity needing water for operations. In Idaho there is a law that prevents “water spreading”. This means that if you save water that is designated to a given tract of land, that water cannot be used to the benefit of other land.

Legislation will probably modify this law as more demand is placed on this valuable resource. There are areas of drought in the United States where it is necessary to get a permit to use *potable* water. Conservation laws, where water is not being used to its highest and best use, will surely be at the top of the list for many legislative agendas.

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