Residential Irrigation Design and Installation Guide

By Steve Okelberry

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CID – National Certified Irrigation Designer
CIC – National Certified Irrigation Contractor
CLIA – National Certified Landscape Irrigation Auditor
TLI 5713 Texas Licensed Irrigation Professional

Edited by Jake Parker
Where is Sprinkler Warehouse?

Exit HWY 290 at FM 1960/ HWY 6. Head west on HWY 6. Stay in your right hand lane. Your lane will NOT go on the overpass. You will go through one stop sign. Please stop. About 200’ past the stop sign turn left under the overpass onto Jackrabbit Road. We are on the right approximately 3/4 of a mile down.

If you are coming east on HWY 6, stay in your right hand lane as you approach Hempstead Highway. The first stop will be Jackrabbit Road. Turn right.
Introduction

My name is Steve Okelberry and I want to welcome you to our repair class. I am a person who truly loves irrigation and the beautiful results it brings to our life. What began as a sprinkler system contractor business with my dad became a life-long pursuit and career. Despite the fact that it’s been a few years since I worked as a contractor, I take the time to maintain my certifications and licenses as a contractor.

I started this class as a way to share some of my knowledge and passion and as a way to give something back to all my loyal customers.

I enjoy teaching and sharing not only the knowledge but the stories I’ve seen and heard through the years. Don’t feel bad if you don’t know anything or if you have made a mistake. I promise you I have met someone who knows less and has made far bigger mistakes. I’m here to help you with your system design, installation and troubleshooting.

The drought we have experienced over the last years makes proper irrigation more important than ever. A properly designed and installed system helps the lawn and flowers, conserves water and saves money. This is what our classes are all about. Save water, save money, save time, build confidence and end up with a great looking yard.

For our training classes I’ve partnered with Jake Parker, also a Texas licensed irrigator. Jake is the tech writer for our blog, sprinklerwarehouseblog.com, moderator of our online forum, sprinklertalk.com, and editor of this manual. He stays active in the field working with customers and their on-site repairs weekly, helping him keep current with the difficulties consumers face with their systems. Finally, he brings years of teaching experience from Compaq Computer and DeVry University.

Sprinkler Warehouse

Sprinkler Warehouse is the premier online provider of irrigation supplies. We are the largest on line provider in the nation. Because of this we offer pallet pricing on every part, whether you buy one or one hundred. We also maintain the most modern and exciting showroom in the industry, staffed with knowledgeable and friendly staff.

I am a customer, just like you. I know what I want when I purchase a product. I’ve designed Sprinkler Warehouse from the beginning to meet these needs.

Our products are all brand new with warranties. No seconds or refurbished products. We stock major name brands, known worldwide. We cover the entire spectrum of lawn irrigation, from the pump to get it from the well to the spray heads and rotors to the final drip emitter.
http://www.sprinklerwarehouse.com

The nation’s largest online irrigation supplier.

Everything you want at the lowest prices

http://www.sprinklerwarehouseblog.com

Troubleshooting and advice articles

by professionals from all across the nation.

www.irrigationrepair.com

Tutorials and videos on everything irrigation

http://www.irrigationproductreviews.com

Find out what people just like you think about different products

Completely independent product reviews
What do you get when you walk into Sprinkler Warehouse?

Everything.

We have the lowest prices, guaranteed. Not just against your local hardware store. Not just against the big box stores like Lowes or Home Depot. Lowest against any reputable irrigation retailer, local or on-line.

We have the best people. Friendly? Of course, but there is more. Our staff is also knowledgeable and experienced. Did you just buy a controller but not sure how to set it? Don’t bother with the instruction book. Our staff will walk you through the settings, taking all the time you need.

We have the most modern and exciting showroom anywhere. Now, that’s a big boast but it’s backed up by comments from all of our national manufacturers. Air-conditioned, carpeted, bright, products on display and plenty of room. On top of that we have iPads at each section describing the product. Have a question on the valve? Touch the iPad above it and pull up all the specs. Need more information? Walk over to our large screen (50”) monitor and look through our site and our how-to videos. All the information is there.

Ready to purchase? We are ready to ship. If you order on line by 1:00 pm Central time we ship the same day. Coming in? Order and pick up right now. Or combine the service: order online and we’ll have it ready for you to pick up when you get here.

Have a vague question? Design problem? Not really sure what you want to ask but know you need an answer? We are here with answers. You can chat on-line, call or come in. We’ll find the answer for you.

Finally, we have on-site licensed irrigators to help you with your questions. One is not only licensed but trains other irrigators. He’s seen it all. One is the company owner and has state and national certifications. There is very little he does not know. The third maintains the blog and the forum, answering customer questions and writing new articles to make sure you find the answers to all your questions. He gets questions and information nationally on a daily basis. We will have your answer.
Our delivery area
Welcome to Sprinkler Warehouse's sprinkler system installation school. This guide is laid out in easy to follow steps with colorful illustrations and cutting edge animations.

Installing an underground sprinkler system can be a do-it-yourself project that will allow you to save almost half the cost of a professional installation. Sprinkler components available today are much easier to work with and provide a more cost effective method for maintaining a lush, green lawn. As with any project, good planning will save you time, effort and money.

**Before beginning your irrigations project, contact your local water company or the proper municipal authority for information on building codes and required permits.** They can also tell you about requirements for the *backflow prevention devices* required in your area. These devices protect your water supply from contamination and are required for most in ground irrigation systems.

**Call 811!**

Call 811 a few days prior to digging. Tell the operator where you're planning to dig, what type of work you will be doing and your affected local utilities companies will be notified about your intent to dig. In a few days, they'll send a locator to mark the approximate location of your underground lines, pipes and cables, so you'll know what's below - and be able to dig safely.

Remember: always call 811 before you start any digging project! You'll avoid injury, expense, embarrassment - and a very inconvenient day in the dark.

**IN THIS SECTION YOU WILL NEED:**

<table>
<thead>
<tr>
<th>Screw driver</th>
<th>Hammer</th>
<th>Tape measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharpshooter</td>
<td>Trenching shovel</td>
<td>Line marking paint</td>
</tr>
<tr>
<td>Flow and pressure gauge</td>
<td>PVC cutters</td>
<td>Solvent, primer, rags</td>
</tr>
<tr>
<td>Marking flags</td>
<td>Teflon tape</td>
<td>Sidewalk sleever</td>
</tr>
<tr>
<td>Adjustable pliers</td>
<td>Hand pump</td>
<td>Wire strippers</td>
</tr>
<tr>
<td>Tamper</td>
<td>Solvent/primer caddy</td>
<td>Marking pen</td>
</tr>
<tr>
<td>Safety glasses</td>
<td>Gloves</td>
<td>Hacksaw</td>
</tr>
</tbody>
</table>

*Information sheet and graph paper* are provided at the back of this book.
Gather your information

**DRAW YOUR PROPERTY**

Each small square on the graph paper should represent one square foot of actual property or use a scale such as 1 inch = 10 feet, 1 inch = 20 feet, etc. Using a tape measure, measure your property and draw it to scale on the layout paper. Use the drawing below as an example:

**REMEMBER**

- Outline your house, garage and other structures.
- Show walkways, drives, slabs, patios and other surfaces.
- Identify trees and major obstacles.
- Measure and record the perimeter of your property.
- Identify slopes.
- Show groundcover, grass, flower beds and landscaping.
- Identify the size and location of the water meter (or pump) and main line.
- Identify the soil type in your yard.

**Write the scale of your drawing on your information sheet!**

**DETERMINE YOUR SOIL TYPE**

There is a simple way to determine what type of soil - sand, loam or clay - you have in your yard. All it takes is a clean, empty jar with a lid, some clean water, a tablespoon of detergent and a sample of the soil you want to test.

1. Fill the jar about 1/3 full with the soil to be tested.
2. Fill the jar with water and detergent then cap it.
3. Shake the jar vigorously and set aside for several hours or overnight.
EVALUATE THE RESULTS:

SAND If the water is clear and the soil has settled to the bottom; you have predominantly sand soil.

LOAM If the water is still a little murky with bits of matter suspended in it; you have loam soil.

CLAY If the water is still murky and there is a visible ring of sediment around the jar; then your soil is mostly clay.

Write your soil type on your information sheet!

CHECK WATER PRESSURE

Using a standard pressure gauge, begin by determining the level of the water pressure produced at your outdoor faucet. Screw the pressure gauge onto the nearest faucet to the water meter. Make sure no water is running anywhere inside or outside your house. Turn on the faucet with the gauge attached. The gauge shows your water pressure in pounds per square inch (PSI). Allow water to run into a 5-gallon bucket to measure the amount of water released in one minute. You may also call your local water company to find out your water pressure. This information, along with a scaled drawing of your lawn, will be used to determine the layout of your sprinkler system.

Once again, you can do this yourself. However, a much easier alternative is to let the experts take care of it for you. Several manufactures (Rain Bird and Toro) will provide you with a system layout and a material list for little or no cost. The layout will include details such as how many zones and zone valves will be needed for your lawn, the amount of pipe needed, the placement of your sprinkler heads, and a complete materials list.
Write the pressure reading on your information sheet.

**IDENTIFY WATER METER SIZE**

The meter size (5/8" , 3/4" or 1") is usually stamped on the outside of the meter. If you can't find the size, just call the water company, they'll know.

Write the meter size on your information sheet.

**IDENTIFY WATER SUPPLY LINE TYPE**

Next identify if your supply line is Copper, Galvanized, or PVC. Copper is generally a copper color, galvanized is generally silver and textured in appearance and PVC is usually white.

Write the supply line type on your information sheet.

**IDENTIFY WATER SUPPLY LINE SIZE**

Find the pipe that runs from the water meter to your house. Wrap a piece of string around the pipe, mark it, then measure how much string it took to go around the pipe. Check your string length on the table below to find your service line size. For example, if your string measures 4" and you have galvanized pipe, your service line is 1 inch.

**Determining Size of Service Line**

<table>
<thead>
<tr>
<th>Length of String</th>
<th>2 3/4&quot;</th>
<th>3 1/4&quot;</th>
<th>3 1/2&quot;</th>
<th>4&quot;</th>
<th>4 3/8&quot;</th>
<th>5&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of Copper</td>
<td>3/4&quot;</td>
<td>1&quot;</td>
<td>1 1/4&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Galvanized</td>
<td>3/4&quot;</td>
<td>1&quot;</td>
<td>1 1/4&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of PVC</td>
<td>3/4&quot;</td>
<td>1&quot;</td>
<td>1 1/4&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Write the service line size on your information sheet.
Get a measurable container, like a 5 gallon bucket, make sure no other water is running in or outside the house, turn the faucet on all the way and time how long it takes to fill the container.

Our 5 gallon bucket took 17.5 seconds to fill so; number of gallons divided by number of seconds to fill x 60 seconds = GPM (5 divided by 17.5 x 60 = 17.14). Round your answer down to the nearest whole number. Our example gives us 17 GPM.

Note: For pump systems, check with your well and pump dealer or the owner's manual of your pump to determine its pressure and flow capacity.

Write your water capacity on your information sheet.

Include lawn, sidewalks, driveways, and walkways and don't forget the house. It's a good idea to sketch everything on a piece of scratch paper, and write in the measurements before drawing your final plan on the graph paper supplied. Then, just transfer everything, to scale, to the graph paper.

- Mark your water meter or pump location with a box □.
- Mark your desired timer location with a circle ○.
- Mark your desired manifold locations with an X.

On your graph paper, each 1-inch square can be 10, 20, or 30 feet. Decide your scale and write it on your information sheet (important). Maximum lot size for Rain Bird's Design Service is 240 x 300 feet.
Consider your area and requirements

**DIVIDE LOT INTO SECTIONS**

Divide your layout into sections; pick out the different areas like, the front lawn, side lawn, flowerbeds etc.

Be sure to label all areas of your yard that you want watered. Rain Bird will make sprinkler head recommendations. If you have special watering requirements, such as wanting bubblers, label these areas. For the types of sprinkler heads that are available, refer to our online Underground Product Catalog. Also, if you have a particular area you want watered separately, such as gardens, roses, etc., mark that area 'separate valves.'

Group similar types of plants together, like shrubs and ground cover. If you have big differences in the amount of sun different areas get, you may want to group them.

**LOCATING YOUR SPRINKLERS**

Now that your drawing is divided into sections, you can take them one at a time. You'll need to plan the sprinkler locations so that the spray from one sprinkler will reach to the other sprinkler location. This is called 'head-to-head' spacing or coverage. You'll need to check the distance of throw and spray pattern of each type of head to do this part of your layout.

**REMEMBER:**

- Choose "small to medium" area sprinklers for areas smaller than 25 by 25 feet.
- Choose "medium to large" area sprinklers for areas larger than 25 by 25 feet.

Draw in your sprinklers starting at the corners, then if needed, draw in sprinklers around the edges of the area. If needed, draw sprinklers in the middle. Keep sprinklers evenly spaced and remember to overlap head-to-head.

**Head-to-Head Coverage.**

The goal in adding an irrigation system to your yard is to have lush green grass and plants. If you install a sprinkler system and did not calculate your spacing properly between your rotors and or sprays you are likely to have brown, dry spots from under watering or have other areas in the
lawn showing signs of over watering. Doing it right on the install is key. And if you keep in mind a few pointers it can also be simple to plan.

The absolute number one rule in spacing is called "**Head-to-Head coverage**" or Head-to-Head spacing. Head-to-Head coverage applies to both sprays and rotors. In a nutshell it means that the heads are spaced so that they overlap from head to head. Each head should throw water far enough so that it hits the next head. If you were to use a standalone method you will most likely see dry brown spots in areas of your lawn due to insufficient watering. You may be able to add extra time watering as a remedy, however this is wasteful and costly. Imagine drawing circles that do not overlap, there would be areas that are not covered. If you used this method (known as a stand-alone method) you would certainly have areas that have left dry brown spots.

The factors to take into account when designing the spacing of your system may include:

- Sprinkler Head
- Water Pressure
- Slope
- Location
- Type of plants
- Wind conditions
- Gallons Per Minute (GPM)

You will need to consider the following things to determine the amount of zones necessary to complete your plan:

- Sun vs. Shade
- Trees and Shrubs
- Annuals & Vegetables
- Containers
**Scale** If your landscape is large you can keep each area zoned separately. If your landscape is small you can try to group plants that have similar but not identical needs together in one zone. For example, you could put your flower beds, hedges and ground cover in a zone.

**Slope** Any area with an incline of more than 10% should be zoned separately. Slopes require special planning to avoid unwanted runoff. A way around this is to create flat terraces held in place by retaining walls. Low precipitation devices set at the correct angles will be needed to irrigate a sloped area.

**Special Needs** Some plants have special watering requirements. For example, roses should not have water on their leaves. If you have roses you may want to use a bubbler or micro irrigation instead of a sprinkler. Plants that are drought tolerant can also be watered separately.
Spray patterns and rotors/sprays

Rectangular Spaces:

Mark your sprays in the corners first and then if needed add your sprays along the perimeter. Proportions of the area can make placement simple. For example, a 30-by-60 foot lawn can be covered by six 30-foot rotors. One rotor in each corner and one in the middle of each of the 60ft sides. Dimensions that do not divide precisely can be calculated by adding a head in each corner followed by adding the fewest amount of heads required along the sides. If the area you are plotting is wider than the throw distance for your chosen head you will add additional heads down the middle if the section too.

Narrow Spaces:

Narrow areas can be watered using strip-pattern spray nozzles. Strip pattern spray nozzles disburse water in a rectangular pattern instead of a circular pattern. Three shapes are used to provide head-to-head coverage. A side strip is positioned along the side of a long strip. A center-strip is positioned in the middle or center. A corner strip is positioned in the corner, which has a spray arc that covers half of the side of the strip. Strip patterns generally cover widths of 4 to 5 feet and lengths of up to 30 feet.

Irregular Spaces:

For areas with curvy or irregular areas you will use spray heads with adjustable pattern nozzles. Adjustable pattern nozzles will allow you to adjust the spray throw to fit the area. There may be situations where equally spaced heads will not cover an area fully. Adding an additional head with smaller or greater coverage to fill in the space may be necessary. Try to keep over spray to a minimum and avoid areas that hit your house, fences, tree trunks or any surfaces that can be damaged by excessive moisture.

Rotors or Sprays?

The size of the area which needs to be irrigated is the main factor that will determine whether to use a rotor or a spray in any area in your irrigation layout. Rotors can cover a much greater area which makes them suitable for areas that are expansive. Some of the benefits of using rotors are that they can be spaced out farther apart which requires less heads to get the job done and less trenching. The maximum throw for a rotor is around 70 feet and the minimum throw of approximately 20 feet. In comparison sprays throw water a much smaller distance (4 to 17 feet)+ so they are suitable for smaller areas. Many irrigation designs will call for a combination of both
in addition to drip irrigation efficiently cover the landscape. **Rotors and sprays cannot be on the same zones however, because they have different precipitation rates.**

**Rotor and Spray Performance Guidelines**

Subtract an additional 10-15% from the recommended rotor or spray's maximum water throw for your desired model. Most manufacturers perform quality testing in controlled indoor environments. The tests are performed in artificial environments so that they can get results which are consistent, accurate and repeatable. Unfortunately this does give accurate performance calculations on how your rotor or spray will perform in your yard when real life factors like wind and humidity exist.

Another pointer regarding sprays is to never turn a spray down more than 25% of its rated throw because your distribution of water becomes poor (most manufacturer's note this point in their model specs).

**Plotting Sprinkler Placement**

You can take the principles from this sample and incorporate these principles in your design. There are two main types of spacing used in irrigation plans, square spacing or triangular spacing (also called staggered spacing).

* **You will need a compass to plot your sprinkler placement on your plan.**

**Square Spacing**

Square spacing is the easiest to plot, the downfall is that there will be areas that are going to be covered by all four heads causing some over watering. Sprinklers are spaced relatively close when using a square pattern (on average around 50% of the diameter of the throw). This means you will also need more heads to cover an given area.

**Triangular Spacing**

Triangular spacing is plotted using three points which means that more surface area is watered with less overlap. Since you can cover more surface using triangular spacing you will be able to space the heads farther apart (usually around 60% of the diameter of the throw). Using a triangular pattern in plotting sprinkler heads can save money because less heads are needed to irrigate any given area. To begin plotting using a triangular pattern start by choosing a side of a rectangular or square area as a baseline. Next plot a heads in each corner.
Followed by placing the third head in between and across from the two you have plotted (see illustration as reference). When you go to plot the next row of your triangular pattern you will shift or stagger the pattern (similar to laying bricks).

**General Guidelines and Special Situations**

**Symmetrical Courtyard with a Walkway**

Avoid watering the walkway by using a combination of spray patterns.

- 90 degree (quarter)
- 180 degree (half)
- 360 degree (full)
Triangular Shaped Spacing for Obstacles

Avoid an obstacle using triangular spacing. Watering an irregular grouping of plants using triangular shaping.

Reducing Water Loss on Corners

Reducing water loss on corners.

Curved Areas

Irrigating the inside or outside of a curved area like a walkway.
Deciding on zones and piping

**DIVIDE YOUR SPRINKLERS INTO ZONES**

Now that you have your sprinklers drawn in and you have found out your home's water capacity (GPM), you will need to determine how many valves it will take to operate them. You need to figure out how many sprinklers can be run at one time by your home's GPM. System design is restricted to 24 GPM maximum.

**EXAMPLE**

Household Water Flow = 17 GPM  
Number Of Sprinklers = 28  
GPM Used per Sprinkler = 1.5 GPM

\[
\begin{align*}
1.5 \times 28 &= 42 \\
42 \div 17 &= 2.47 \\
\end{align*}
\]

3 ZONES REQUIRED

- GPM per Sprinkler will vary depending on the type used. Check performance charts for accurate numbers.
- Round this number UP to the next whole number.
- You will need to do this calculation for each section of your layout to figure out your total number valves (zones) for the entire system.

**DRAW IN YOUR PIPES AND VALVES**

Now that you have figured how many zones you need, you know how many valves to install. Remember, you need a valve to control each zone.
Wrong way to lay pipe

Right way to lay pipe

Use this chart to size your pipe according to GPM needed for each zone. Label the pipe on your drawing. Remember to size your connecting pipe to the largest zone.

Max Flow for PVC pipe

- 3/4” Class 200: 10-12 GPM
- 3/4” Sch. 40: 7-9 GPM
- 1” Class 200: 16-20 GPM
- 1” Sch. 40: 12-15 GPM
- 1-1/4” Class 200: 26-32 GPM
- 1-1/4” Sch. 40: 22-27 GPM
What Size Pipe Should I Use?

Figuring out what size PVC pipe to use for your sprinkler system doesn’t have to be difficult. The diagram below represents what we recommend for the average household. This diagram is based on a 5/8” water meter. If you need more help, feel free to ask one of our knowledgeable staff.

Three Rules for Connecting To a Water Meter:

1. Do not exceed 10% of the static water pressure as a pressure drop through the water meter (e.g. if your static pressure [when all valves are closed] is 60 PSI, then you cannot have a pressure loss greater than 6 PSI when the system is running. 16 GPM is the maximum flow that can be pulled through 1” PVC pipe without causing a pressure loss greater than 6 PSI).

2. Do not pull more than 75% of the maximum safe flow capacity of the water meter (e.g. if you have a 5/8” water meter, the maximum flow you can pull is 20 GPM. 75% of that is 15 GPM. Therefore, the maximum flow you can safely pull for your system is 15 GPM).

3. Do not go beyond velocities of 7 feet per second in the service line (e.g. in order to figure out the Feet Per Second [FPS], you can run the equation or refer to a friction loss chart. After looking at the chart, I see that I can pull a maximum of 18 GPM through my 1” Sch. 40 PVC pipe system and not exceed 7 FPS).

To avoid water hammer and pressure loss, it is a good idea to apply all three rules to your system, and choose the one that gives you the lowest GPM. In this example, it happens to be rule number 2 at 15 GPM. 15 GPM is what I should design the sprinkler system to run on.

So, if my water is 5/8” and my pipe is 3/4” why should I use a 1” PVC pipe for my system? Well, simply put, any restriction that you have in flow, you want it to be because of the meter and not your system. Designing with a slightly larger pipe than you “need” will always allow your system to pull all water possible.
Controller considerations

There are a variety of timers and controllers available for your system. You will need one with a "station" for each of your valves. You might even purchase one with extra stations in-case you add to your system at another time. Locate your timer in a place that is easy to get to, like the garage or basement, near a 110 volt outlet. To wire a timer use coated irrigation wire which is rated for underground burial.

Get enough wire to reach from the timer location to the farthest valve, then add a few feet just to be safe. The connections at the valves should be made with water tight connectors. There are two connectors for each valve.

You should connect a rain sensor to your controller. This prevents over watering by shutting down the controller during/after a rain. The sensor will need to be in a clear area, such as on the eaves of a house or top of a fence. Make sure it is not covered by trees.
**Tapping into your water supply**

It is now time to connect your sprinkler system to the main water line. Double check to ensure you have secured all permits. In addition, have the local utilities mark all the buried lines and pipes before you start digging. Usually it is a matter of tapping into the ¾ inch water line just beyond the meter and upsizing to a 1 inch pipe for the sprinkler system.

Use flags to indicate sprinkler locations according to your design. Also, mark the location of your drip system risers even if you plan to install the actual drip system at a later date, you can install your drip risers with the rest of your system. Use line-marking spray paint to mark where you'll trench for pipes and wiring. Check your worksheet to make sure you mark the lines accurately. You will be digging your trenches along these lines.

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**TAP INTO YOUR MAIN LINE**

By cutting into your service line and slipping on a compression tee, you can connect your sprinkler system to the water supply without soldering. In some instances, you can avoid cutting the main line by attaching your system to the outside faucet connection (see diagram and note). PVC pipe may be substituted for copper in non-freezing areas.

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**SHUT-OFF VALVES**

Whether a PVB is used or not, we recommend installing a shut-off valve between the zone valves and the service line. This will allow you to easily turn off the water to your irrigation system if you need to make repairs or replace parts. Check local codes for the type of shut-off valve recommended.

NOTE: Pipes should be buried at least 6 inches under the ground.
Installation

IF THE METER IS IN YOUR YARD:

1. Shut off your water supply at the meter (check with your water department first).
   • Use pliers or a meter key to turn off meter. Then turn on a hose bib to release pressure.
2. Dig to expose the service line.
   • Dig far enough around the pipe to give plenty of working room.
   • Dig deep. Water will come pouring out.
   • Have a hand pump handy to remove water.
3. Tie into the service line, between the water meter and the house.
4. Remove a section of pipe, leaving a gap large enough to slide on a connecting tee.
   • Ideally you will have dug up enough pipe that you have some flex in the pipe.
     If so, flex the pipe and install a standard PVC “T”. If not, use a KwikRepair T.
5. Prime and cement one end of the connection FIRST, then do the second.
6. Install a short run of pipe a few feet long.
7. Attach a shut-off (ball) valve, in a small enclosure, to this section of pipe. The shut-off valve allows you to turn off the system by hand, if necessary.
   You will install valve box over the ball valve later.
8. Keep this connection as clean as possible.
9. After cement has dried, close ball valve, turn on water, test fittings.

This is your tap water supply.

MAIN AND LATERAL LINE TRENCHING

The main irrigation line is the pipe that runs from your service line to your valve manifolds. The lateral lines are the lines that run from the valve manifolds to the sprinkler heads. Digging can be done by hand or with a trencher, such as a DitchWich. Both of these methods will allow you to install the pipe and then the low-voltage cable wire. Your trench will need to be 6 to 10 inches deep. Make the main trench first, then add the branch lines. Although it will require more work up front, a deeper hole will make the job easier by providing more room to work with your fittings.
WARNING!

Before digging any trenches, you must have all underground utilities marked to avoid any damage. Call your local underground locator service or the city for information.

TRENCHING BY HAND

To soften the soil, water the ground approximately two days before you dig. Dig trenches 8" to 12" inches deep. Put sod on one side of the trench and soil on the other. This allows you to cover the trench when you are through and have minimal visual damage. When you are through, replace the sod and water thoroughly.

TRENCHING USING A TRENCHER

Trenching machines are an easier, faster alternative to digging with a shovel. They can be rented by the hour, day or week, usually from a lawn supply store or rental equipment dealer. The person you rent from can show you how to operate the machine properly and safely. Trenchers should not be used to dig through ground cover, flower beds, on steep slopes or near buildings. Be sure to verify all underground utilities before trenching. In colder climates a vibratory plow is used for pulling pipe.

Please remember that trenchers are very powerful and can be dangerous. Be careful. Even though they do the digging for you they can be very hard and physically demanding to use. Make sure the unit you get is the proper size for your job.

DIGGING UNDER A PATHWAY

Usually, your yard will contain a few items other than the lawn grass you are trying to keep lush and green. These might include driveways and sidewalks, which at first glance might appear impossible to overcome. Since pipe must go under these obstacles, you will need to find a way to dig a trench without removing the hard surface. The most efficient and cost effective way to bore under an obstacle is to create a hole using the power of water. Simply attach a jet nozzle to one end of a piece of PVC pipe and a garden hose to the other end with the necessary fittings. The force of the water will create a hole the same exact size as your PVC pipe-through to the other side. Large or small areas can be excavated by adjusting the length of PVC pipe. The tool can be reused again and again by adding a coupler to the PVC pipe.
The components needed to bore under an obstacle:

- Brass 2 inch sweeper nozzle (1 qty)
- PVC male hose end adapter fitting (2 qty)
- Brass 3/4 inch female hose to 3/4 inch female pipe swivel (1 qty)
- Brass 3/4" male hose to 3/4" female pipe (1 qty)
- PVC glue
- Garden hose

First dig your trenches on either side of the walk to the depth of the rest of your sprinkler system (usually about 6-12 inches minimum). Now using a PVC pipe cutter, cut the piece of schedule 40 PVC pipe about two to four feet longer than the width of your sidewalk or driveway. Following the directions on the can of PVC glue and glue the male adapters on opposite ends of the PVC pipe. Next, attach the brass 3/4" female hose to 3/4" female pipe swivel to one of the PVC male adapters. Then attach the brass 3/4" male hose to 3/4" pipe fitting to the other PVC male adapter on the opposite side. Connect your garden hose to female pipe swivel adapter. Connect the male hose/female pipe adapter to your 2 inch sweeper nozzle. Your boring tool is now assembled and ready to go.

Turn on the water. Grab hold of the pipe (fitting the pipe into the trench may initially require some flexing). Keep the pipe level with the bottom of the trench and jab the boring tool into the soil. The dirt will appear to plug the end of the nozzle, just leave the nozzle in place for 15 to 30 seconds to allow the water to loosen the soil. Pull back the pipe 6 inches to a foot and thrust it into the soil again. Keep repeating this pattern until you have completely bored under your driveway/walkway.

Once the pipe has made it through to the other side you can shut off the water and cut the hose end fittings from both ends of the pipe. Your PVC pipe tool now becomes your irrigation pipe. Attach your fittings to the pipe and continue to assemble your irrigation pipe. Some people prefer a variation of this method and use a larger PVC pipe to bore the hole; once they have bored through to the other side they push the actual pipe being used into and through the boring pipe to the other side of the path or driveway. The boring tool then acts like a sleeve. Then the larger "boring" pipe also can be used to hold irrigation or lighting wire. This method allows you to bore just one hole for multiple purposes.
NOTE: Soil that is too hard or rocky may require tunneling either by hand or with a machine that can bore a hole under the sidewalk. You can also contact an irrigation or landscape contractor to do the job.

Sidewalk Sleever  One of the best devices to have if you have a job that requires excavation under a pathway is to use the Sidewalk Sleever. Just follow the simple steps below to see how quick and easy your job could be using this tool.

1. Place a piece of pipe next to the Sidewalk Sleever with one end touching the "pipe stop" and mark; with your finger; where the pipe just meets the tapered end. Then cut the pipe at that point. If the pipe is past the tapered end this will allow dirt to enter the pipe during installation.

2. Take the cut pipe (sleeve) and slide it on the Sidewalk Sleever. It is important that the Sidewalk Sleever is clean. Dirt on the tool will make extracting the tool difficult.

3. Place the Sidewalk Sleever just under the concrete and tap in a few inches. This will allow the tool to hold itself off the ground making it easier to install and also easier to remove the tool after installation.

4. While straddling the trench; use a 16 pound sledge hammer to impact the Sidewalk Sleever under the sidewalk. Continue impacting the tool until the tapered end appears at the other end

5. Once the tool and pipe are visible at the other end; simply grab the impacted end of the tool and remove from the installed pipe. If necessary; tap the pointed end of the tool with the hammer to help the sidewalk sleever slide out of the pipe.
Installation of main line

Begin your system layout next to the house where you will be making your water supply connection.

Attach the main sprinkler line to the service line. Run it along the bottom of the trench from the house to the backflow preventer. **The type of backflow you use will be determined by local codes. Check first.** PVB backflows, the most common, should be installed close to the side of the house for three reasons. 1. It helps discourage theft. These are brass and can be sold as scrap. 2. The house can provide a location to fasten a stiffener/brace on the PVB if required. 3. The better sheltered the PVB is the smaller the risk of freeze.

A PVB MUST be installed one foot above the highest head in the system. If the installation gets tall, over 2 feet or so, consider running a brace to the near wall. Insulate the pipe to and from the PVC with pipe insulation and wrap. DO NOT wrap the bell of the PVB. This must remain open to function.

**Pressure Vacuum Breaker Assembly: Installation**

The irrigation system site plan will indicate the location of the pressure vacuum breaker assembly. It should be as close as possible to the isolation valve and within a few inches of a trench leading to the zone control valves.

Before installing the pressure vacuum breaker assembly, run the supply pipe to the location of the assembly in accordance with the site plan and, if necessary, use an elbow to turn the supply line vertical and upward. Glue a long riser into the elbow. This riser will be cut to the correct height in the next step.

Determine the minimum installation height. Find the highest outlet on the system. In a relatively flat landscape, this is likely to be at the top of a shrub watering riser or sprinkler head. It may be necessary to drive a stake where the riser will be and mark the height of the outlet. Use a laser or string level to find and mark this height on the pressure vacuum breaker assembly riser. On the pressure vacuum breaker assembly riser, measure up twelve inches and place a second mark. If the riser isn't tall enough, extend it with a coupling. This mark represents the height of the vertical center of the outlet valve. To get the assembly installed at this height:

**If the assembly has built-in unions between the shutoff valves and the interior body:**

1. Line up the pressure vacuum breaker assembly so that the outlet is centered at the height of the second mark and the inlet is downward. Place a third mark on the riser at the
bottom of the pressure vacuum breaker assembly inlet valve. Cut the riser on the third mark.

2. Open the isolation valve to flush out any foreign material in the supply line. Close the isolation valve, and dry the end of the pipe. Use a towel to wick water down if necessary so that the top few inches are empty and dry.

3. Using pipe sealant compound, tighten PVC Slip X MIP adapters into the inlet and outlet shutoff valves on the assembly. Position the assembly on the riser so that the bonnet is on top. Turn the assembly so that later shelter cover can be installed in the most visually satisfactory position. Glue the inlet adapter onto the riser working quickly to avoid damaging internal parts.

4. Cut a three to four inch length of PVC. Glue an elbow onto one end, and then glue the other end into the outlet adapter so that the elbow is pointed downward. Measure, cut, and glue a length of pipe long enough to extend from the elbow to three inches above the bottom of the trench. Skip the following instructions for installing unions.

Following the manufacturer’s instructions, test the assembly for leaks, then schedule an inspection if required. The last step in the installation procedure is to put all printed materials in a safe easy-to-remember location along with other irrigation literature. It will be needed in the future.

**AFTER THE BACKFLOW**

At this point you start laying out your PVC to the individual valves. DO NOT run your wire yet. There will be plenty of time for that later and it will just get in the way.

Once you have your pipe cut do a practice assembly. We do this to make sure we don’t glue the elbow on facing the wrong direction. Lay the pipe out along the trenches. Put the elbows, Tee’s and 45’s on just as if you were putting it in the trench. Once you are sure it is correct draw a line on the fitting and pipe with a marker or crayon. This will help line it up for you when the cement is on and drying fast.

Once everything fits and has been double checked, assemble your piping up to and including the valves.
WORKING WITH PVC PIPE

With PVC pipe, you will need to clean any burrs from the pipe after making a cut, and then prime and glue using the correct PVC specific product. Give fittings a slight twist as they go on. Tee fittings are used to splice into a continuous run of pipe.

1. Cut pipe with a PVC pipe cutter or hacksaw
2. Wipe the ends of the pipe to remove burrs
3. Brush on a primer to clean the pipe surface and the inside of the fitting
4. Brush glue on the outside end of the pipe and lightly inside the fitting
5. Slip the pipe into the fitting and give it a quarter turn
6. Hold in place for about 15 seconds so the glue can set
7. Wipe off excess glue with a rag

NOTE: Wait at least one hour before running water through the system. Check with glue manufacturer's recommendation.

IN-LINE VALVE INSTALLATION

In-line valves are installed below ground and should always be installed in a protective valve box. Dig out the area where in-ground valves are to be installed and add several inches of gravel to the bottom of the hole. Place the top of the valve box so that it is even with the surface of the ground.

Note: all valves have an arrow indicating flow direction. Make sure you install the valve correctly.

Tip: Look for valves with the flow control feature. It saves water
Valve locations

There are two schools of thought on locating valves. One is manifold, or cluster, oriented, the other one is area oriented. Area oriented is preferred. First we’ll discuss manifolds.

Clustering or manifold installation.

A group of valves running off the same supply line is called a manifold. In this you group your valves in one or two areas. For example, one control valve manifold to operate front yard zones and one to operate backyard and/or side yard zones. The advantages to this are you know where the valves are and you use less wiring, as everything is near the controller.

The disadvantage is that in irrigation pressure is king. You want as much pressure to each zone as possible. In clustering you run your main line to the valve. The valve causes pressure loss. Now, even if you go back to a larger pipe you are starting with reduced pressure. Ideally you want to run as big a pipe as possible to the valve then go directly to laterals, which don’t require as much pressure.

Area Installation

The other, and better, idea is to locate the valves in the zone they will handle. This lets you run your larger main to the valve and delays pressure loss through the valves until the last moment.

Simply locate your zones, consider your digging pattern, and locate valves centrally. The downside is an increase in wiring requirements. This is offset by the increased pressure available to each zone.
Trenching

Try to minimize your trenching as much as possible. When possible, use your main line trench for zone piping also. Aim towards the center of zones, hold relatively close to planters, walks and buildings to allow for zone pipes to share the trench. Look at the red line. This represents trenches. Notice how the trench and the control valves follow the zone layout.

**Note:** If one of the valves will be used for drip irrigation, leave enough room between the valve and the sides of the valve box for the filter and pressure regulator that are part of your drip system. It may be a good idea to install those parts on the valve, then, install the valve in the valve box.

**INSTALL LATERAL PIPE**

Start from the valves and move outward, laying the connecting pipe along the bottom of the trench.

**FLUSH SYSTEM TO CLEAR DEBRIS**

After the pipe has been connected and the glue has dried (PVC pipe only), turn on the water, open valves one zone at a time and flush until the water runs clear. Seal the fitting with duct tape to keep dirt out until the sprinklers are installed.

**NOTE:** Don't backfill your trenches until your final system operation check is complete.
Installing laterals and heads

Make your sprinkler head choice based on the job you need it to do. Small areas are best serviced by spray heads, whereas rotary heads take on the task of covering larger areas. A bubbler head can be a great addition to a flowerbed where you need deep penetration without getting the foliage wet. Bubblers run a slow application of water through a 1/4 inch tube, thereby allowing for less frequent watering.

Using PVC Pipe

1. **Install Fittings** Cement fitting to the end of the pipe. Adjust the fittings to fit the space as necessary. Be sure to give the pipe a 1/4 turn to spread the solvent. Make sure to plan ahead so that the tee is facing straight up; remember that solvent cement dries very fast. We recommended waiting at least two hours before turning the water on again.

2. **Install the Risers** Using the appropriate height and type of riser for the location (here we use a Hunter Swing Joint Riser), wrap the riser threads with pipe-thread tape and screw the riser into the tee fitting. Swing joints give flexibility in location and are better able to absorb shock, reducing the risk of damage if a mower or car run over the head.

3. **Attach the Sprinklers** Attaching the sprinklers is easy! Just screw them onto the riser. Position the sprinkler in the trench so that the top of the sprinkler is flush with ground level. Keep the sprinkler in an upright position while filling dirt in around the sprinkler body and tamping the soil around it every 4 in. Repeat this process for each sprinkler.
Wiring the timer/controller

1. If you haven't already done so, lay the valve wires in the bottom of the trenches, beneath the pipes. This helps prevent accidental cutting by shovels and tent stakes.

   **Tip: Installing more wire strands than your system currently requires can be a real time saver. Adding them now is simple; adding them later after all the dirt is back in place and the grass is growing is not.**

2. Connect the valves to the timer using the valve wires.
   - Take one wire from each valve and connect them to a common wire. (For ease of identification, use the white wire as the common.)
   - The common wire is just that: common. You may have one white wire that connects to each valve or you may have 2 or 3 that splice back into the main common.
   - Each valve will have its own control wire. Seven zones means seven control wires.
   - At the timer, connect the common wire to the common terminal on the timer.
   - Take the other wire from each valve and connect them to the timer terminals in sequence.

   **WIRING**

   There are two kinds of wire available: single and multi-strand. Whichever you choose, make sure it is approved for direct burial.

   The convenience of multi-strand wire only comes into play if you put all your valves into a manifold/cluster location. Then it is more convenient to run. However, it is smaller, 18 gauge, not as flexible or as durable as single strand wire.

   Single strand is the best way to go. It is 16gauge, durable, able to bend and flex a great deal without breaking and will last much longer.
When you make your field connections you must use a waterproof connector. If you don’t the connection will fail in a short time due to corrosion and your valves will not activate. These have silicon grease that surrounds the connection, preventing moisture penetration. Do NOT use electrical tape. It will fail almost immediately. There is no location in irrigation wiring where electrical tape is appropriate.

Testing

**CHECK YOUR SYSTEM OPERATION**

1. Slowly turn on the water, then manually open an irrigation valve.
2. Adjust the sprinklers to ensure proper coverage.
   (See sprinkler installation instructions for details.)
3. If you don't have complete head-to-head coverage, follow the steps below:
   - Make sure the control valve and shut-off valve are fully open.
   - Turn off any water being used in the house (washers, showers, faucets, etc.).
   - Fine-tune sprinkler spray positions and spray patterns to match your coverage area.
   - If coverage is still not complete, go back and check your system layout against the plans.
   - When you see that the coverage is satisfactory, fill in the trench.
   - Once you are satisfied with your installation you can move on to installing your drip irrigation system.

You have now completed you Sprinkler System Installation
Progressive Design Illustrations

Step 1:
Get some grid paper.
Choose a scale (e.g. 1 square equals 5 feet)
Draw out your property
Grid removed for clarity

Don't forget to include all landscape features:

1. Walks
2. Drives
3. Decks
4. Planters
5. Trees
6. Storage building
7. Any permanent structure
Be as accurate as possible with layout and measurements.

If you know you are going to add a feature shortly, such as a new planter in the back yard, sketch it in. You can decide later if you want to design around it or not.
Divide the yard into areas that you would like to water at the same time (e.g. front yard, back yard, flower beds)

This is a rough starting point. Consider each area to be watered and what areas might be watered together.
Plan out where each sprinkler head will be placed.

Use the sprinkler radii as a guide for sprinkler placement (remember head-to-head coverage).

There are a lot of free design services that will help you with this step.


Up to approximately 15’ you can use a spray head.

Above 15’ you would use a rotor.

A compass or circle template will be of great benefit here.

Be sure to put a good mark where the center of your radius is located.
NOTE: never mix rotors and sprays in the same group.

Now look at the head layout. Do any obvious groupings appear?
Using the chart below, write out the gallons per minute (GPH) for each sprinkler.

<table>
<thead>
<tr>
<th>Spray Pattern</th>
<th>Rotors</th>
<th>Sprays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarter Circle</td>
<td>2 GPM</td>
<td>1 GPM</td>
</tr>
<tr>
<td>Half Circle</td>
<td>4 GPM</td>
<td>2 GPM</td>
</tr>
<tr>
<td>Full Circle</td>
<td>8 GPM</td>
<td>4 GPM</td>
</tr>
</tbody>
</table>

Standard Pressure

50 PSI

30 PSI

Again, consider zones and how much water each might use.

Circle your expected zones (planter, front right, side, etc.)

This chart is an average and very close. You will get a good, workable design using it.

For the most accurate design, refer to the charts for each manufacturer at SprinklerWarehouse.com.

Each radius and pattern will have a different volume. For example:
Label each head with GPM
Add together all the GPMs you've written down for each sprinkler to get the total GPM
Determine the size of your water service line and meter

With that information, determine the maximum GPM that your line can supply to the system (water capacity charts are available online)

In this example, the maximum that this system can use is 18 GPM

<table>
<thead>
<tr>
<th>Size of Water Meter</th>
<th>Size of Service Line</th>
<th>Water Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>5/8&quot;</td>
<td>1/2&quot;</td>
<td>2.0</td>
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<tr>
<td></td>
<td>3/4&quot;</td>
<td>3.5</td>
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<td>3/4&quot;</td>
<td>3/4&quot;</td>
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<tr>
<td></td>
<td>1&quot;</td>
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<td></td>
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</tr>
<tr>
<td>1&quot;</td>
<td>1-1/4&quot;</td>
<td>12.0</td>
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</table>

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<td>1&quot;</td>
<td>10.0</td>
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<tr>
<td>1-1/4&quot;</td>
<td>12.0</td>
</tr>
</tbody>
</table>

This chart is from the “Orthos All About Sprinklers and Drip Systems” by “Ortho Books”
Copyright 1998 pg. 27

In this example, three of the groups use more than the maximum 18 GPM (48 GPM, 23 GPM, 19 GPM).
Break down any groups using too many GPMs into smaller groups that do not exceed the available flow rate (in this example, the available flow rate for each group is 18 GPM).

Each of these new groups will be a single zone in your system.
Re-design zones to equal less than maximum GPM
Now that the zones have been laid out, we are ready to plan the piping.

Using the flow rate chart at the back of the book, select a pipe size that allows for the flow required by your system.

When connecting to the water supply line use at least Schedule 40 pipe, nothing thinner.

In this example, 1-1/4" Sch. 40 PVC pipe as a main line will allow us to pull the 18 GPM needed for our system.

When planning your system, don't forget:

- Backflow prevention
- Controller/Timer
- Rain Sensor

We can now lay the main 1-1/4" Sch. 40 pipe.

Run the pipe from the meter to the backflow and from the backflow to the rest of the system

NOTE: the white line indicates the water pipeline to the house.

Draw in the placement of the valves.

Best practice is to place each valve as close as possible to the center of its respective zone.

In each zone, we will use 1" Class 200 PVC after the valve (this will still allow adequate flow).

Because the line will not be pressurized all the time, a thicker pipe is not needed.

TIP: try to lay the zone piping in the trenches you already made for the main line.
Supplies

- Controller
- Rain or rain/freeze sensor
- Backflow protection
- Ball valve (isolation valve)
- Supply line tie-in (kwikfix, PVC fitting)
- Valve boxes
- Insulation for above ground PVB and wall weather tape
- Pipe: schedule 40, class 200, 1”, ¾”
- Teflon tape
- PVC primer and cement
- Valves
- Wire: 16 gauge direct burial. One white for common. Balance red
- Waterproof wire connectors
- Swing joints or cut off risers
- Sprinklers bodies
- Spray nozzles
- Rotors
- Shrub sticks/risers
- Shrub adapters
- Misc fitting: connectors, T’s, reducers, elbows, 45s, threaded for PVB
**System upgrades**

A well designed irrigation system puts water where the plants need it. Why not have it add fertilizer while it runs? Anytime you can get your equipment do more work so you do less you win. In-line fertilization will help your plants grow and you rest.

One such system is by **EZ FLO**. It ties directly into your sprinkler system, runs automatically with no extra wiring, and lets you control the amount of fertilizer applied. You can install it to do your entire yard or, if you want to fertilize your vegetable garden only, install it on just one zone.

Because it goes on as a liquid you do not have to wait for the material to be washed in, as you do with granular fertilizers. The system allows for fine tuning the amount applied with a simple twist of a dial. And, because the fertilizer is completely dissolved in the water, it will not harm or cause any performance drop in your sprinklers.

The system is installed out of site, usually underground, and attaches to the existing sprinkler system with 2 small hoses. Once connected you fill the tank, set the application rate, and forget about it. The average residential installation is designed to be refilled every 4 to 6 weeks.

A word of caution: before installing any system that ties into your irrigation system you must have a backflow preventer. Your system probably already has one. Check with your local authorities on approved backflows for this application.
Available products include:

EZ FLO EZG-231310-1 23-13-10 WATER-SOLUBLE ALL-PURPOSE Excellent for St. Augustine grass. The unique nutrient package is designed to repair and detoxify soils damaged by traditional chemical fertilizer applications. Through the rebuilding of the soil structure, EZ-GRO fertilizers promote root development and overall plant health which dramatically reduce weeds and insects throughout your entire landscape.

EZ FLO SOIL FERTILITY BOOSTERS. Non-Toxic, Non-Pathogenic and Environmentally Safe. A Premium series sod, seed and root microbial inoculant product with mycorrhizae. Scientifically selected blend of natural soil microorganisms with an advanced bio-stimulant nutrient base.

LIVE EARTH BIO-STIMULANTS & SOIL CONDITIONERS Live Earth products address the Carbon to Nitrogen ratio which is ever important when gauging a soil's fertility. Live Earth derives its carbon from Humic Shale ores mined from an ancient "compost pile" located in Utah. With its rich source of humates, minerals and enzymes, Live Earth products stimulate the growth of microbes and bacteria which in turn provide food sources targeted to the roots of all plants.

LIQUID "GYPSUM" CALCIUM SUPPLEMENTS & SOIL CONDITIONERS Liquid "Gypsum" is a proven product that helps bind soil particles in clay soils, improves water flows in the soil and removes excess sodium (salt)buildup. A very good substitute for powdered gypsum.

GROW MORE GRM28818-25 WATER SOLUBLE FERTILIZER 100% water soluble powder for root and foliar feeding. This formula will provide a fast green up without excessive top growth. It encourages strong healthy root blade development that deters both fungus and insect invasion. All plant material in your landscape will appreciate this fertilizer for the availability of essential nutrients in this formulation.

Simple, reliable, no wires to run, no separate controller, adjustable and effective. Pretty much all you could want in a fertilizer system.
Skeet-R-Gone

One of the best known and most successful is SKEET-R-GONE. It has a number of distinct advantages, starting with the fact that it does not use poison. It uses all natural ingredients, won't harm grass, plants, people, or pets but insects cannot build a resistance. The formulation has been tested and listed as having no known hazards. You can’t get better than that.

The Skeet-R-Gone also lets you choose which area you want to treat. Ants particularly heavy in the front yard? Treat it again without doing the back. Lots of heavy growth on the side yard? Give it some extra spray time. Completely customizable to your needs.

Notice I mentioned the front yard? That’s because Skeet-R-Gone goes where ever your irrigation system goes. No extra nozzles, no nails in the side of the house, no black tubing running along the edge of your white eaves. And no fence posts in your front yard. If you have a sprinkler head in an area you have pest control.

What does the Bug Slug Concentrate control? Mosquitoes, flies, fleas, gnats, no-see-ums, mites, spiders, fruit flies, fire ants, chiggers, ticks, silverfish, crickets, moths, cinch bugs, ants, palmetto bugs and many more.

Because Skeet-R-Gone comes through your irrigation system the droplets are heavier. They settle in, just as your irrigation does, getting down past the surface of the grass to the ants, roaches and other insects you want gone. And far better about covering the entire yard and the places mosquitoes might hide and breed. Mosquitoes breed in water. You are putting out water that will go to the low places, just like rain. Except yours kills mosquitoes.
Have a critter problem? Deer and raccoons eating your flowers and vegetables? No problem. Use **Critter Repel**. This organic formula is an effective way to drive away deer, gophers, rabbits, moles/voles, mice/rats and coots as well as other landscape pests. Apply EZ Critter Repel directly onto your landscape plantings. This product can be applied directly by spraying it onto the leaves of the plant or with any spray irrigation system equipped with an EZ-FLO dispenser. This product can be combined with fertilizers or applied by itself.

You’ll like it as much as the animals hate it.
Things you should know

The Right Way to Assemble and Glue PVC Pipe

There are many ways to glue PVC pipe and a number of solvents. The bright side is most of them will work. The down side is many of them won’t, wasting time and money, or only appear to work until the pipe is long buried. Then it becomes expensive.

We are going to discuss measuring, fitting and gluing pipe. The premise is that if you do it correctly you only do it once. Not to mention limiting trips to the hardware store and controlling blood pressure.

Before we do anything else, there are two warnings. One on safety, one on product performance.

- Folks, these are harsh chemicals. Don’t get them on your skin. Definitely don’t get them in your eyes. No breathing fumes. Make sure you have plenty of ventilation, as in ‘do it outside’. Wear gloves. Wear eye protection. Care to guess what the cement does to plastic contacts or your expensive glasses?
- There is such a thing as too much glue. This is not Elmer’s Paste. If you put too much cement on and it has a chance to puddle it can and will eat through the pipe or fitting. Now you have a hole in the fitting. Also, too much glue when attaching valves can drip into the valve body and cause failure.

First, get these things together:

- Rags
- Primer and cement
- Something to put the pipe on while you cut (sawhorse, cinder block, table, etc.)
- Gloves
- Hacksaw
- Marker or crayon
- Rough file or course sandpaper

Optional but you should have

- Miter box
- Pipe cutter, preferably ratcheting type though standard will work fine.
- Hammer/Channel Lock pliers

Measuring is the shortest part of this paper. Remember that you have to include the length of pipe that goes into the fitting and the length of the fitting. Say you have a 10’ section from corner to corner. The fittings add length. You need to figure out how short to cut the pipe so you can add the fittings and still get 10’. How far does the pipe go into the fitting? Depends. Depends on the cut, the pipe, your strength. There is a stop designed into the fitting. How far in is it? To find
out, take the pipe and fitting, get them wet with water only, and push the pipe into the fitting with firm but not killer force. The water makes it easier to slide them together. Now take a pencil and mark the pipe at the edge of the fitting. Twist the pipe back out. The distance from that mark to the end of your pipe is your glue area. This can vary depending on fittings and pipe size. Measure everything twice. Write it down.

Cutting the pipe is more important that people realize. The cut should be square and smooth. If you don’t cut it square the short end will not make complete contact with the inside of the fitting and will not bond as it should. It helps to use a miter box, if you can, or good ratcheting cutters. Take your time. It will help avoid problems later.

Ideally the end of the pipe should be smooth with tapered edges. Now I know you don’t hear many people talking about tapering a PVC pipe edge. You’ve probably never seen it and I know many professionals that have never even heard of it. However, we’re discussing the correct way to do this. You can bring in the shortcuts when I’m not looking. If you have a simple square cut pipe it has a tendency to push the cement ahead of it, as in the drawing. A smooth pipe with an edge taper lets the cement flow between the two. So take your file, file off the burrs that are left from the cutting, if any, and add a quick taper to the end. At the very least use sand paper to smooth the edges and take off any burrs.

On to fittings. Once you have your pipe cut do a practice assembly. We do this to make sure we don’t glue the elbow on facing the wrong direction. Lay the pipe out along the trenches. Put the elbows, Tee’s and 45’s on just as if you were putting it in the trench. Once you are sure it is correct draw a line on the fitting and pipe with a marker or crayon. This will help line it up for you when the cement is on and drying fast.

Ok. Pipes are cut, fittings are ready. Now time for primer and glue. First I’d like to clarify one thing. It’s not really glue or cement. It’s a solvent. The solvent basically melts the PVC. When two pieces of PVC are joined using PVC cement the plastic melts, molecules blend, and it re-solidifies to a single unit. That’s a gross simplification of what happens but its close enough. When the cement is through and the PVC has re-solidified it is now the strongest piece. If you do it right the fitting or pipe will break long before the joint.

The first thing you do is make sure the pipes and fittings are dry. There are some cements that don’t need primer and will work with a wet pipe but we tend to avoid them. First, using primer gives us a last chance to check the pipe. You’d be surprised how often a small crack will
hide until the primer hits it. The other reason is that special cement tends to set FAST. Real fast. No room for error or hesitation. Why ask for trouble?

Now prime both the pipe and the fitting. Use just enough to do the job. Too much doesn’t gain you anything. Using the included dauber wipe the glue area of the pipe and the glue area of the fitting with primer. Since it’s purple it’s easy to keep track. By the way, it stains everything so be careful. Primer removes dirt and grease and preps the PVC. When PVC is formed it has a hard, clear coating on it. This is resistant to the cement. Primer removes the coating, exposing the PVC.

Now apply the cement to both pieces. Do the fitting first. Since the cement is inside you can lay it down for a moment while you coat the pipe. Once both are done push the pipe into the fitting, turning about ¼ to ½ turn as you go. This makes sure the cement spreads evenly. Hold it together for about 15 to 30 seconds. Because of the chemical reaction and the way the fittings are formed there is a tendency for push back. The pipe will want to come out so hold until is sets. If you’ve done everything correctly you can look around the edge of the fitting and see a little glue bead that has been push out by the fitting. It should be continuous. A gap might mean a pinhole leak later. Wipe off any excess cement.

I know. I didn’t say what you did with the pliers or hammer. That’s ok. They are always good to have.

That’s it. Doing takes far less time than reading about it. Doing it correctly doesn’t add any time and sure can save you a headache in the future.
How to Identify the Size of the Water Meter & Supply Line

A critical step in designing an efficient irrigation system is determining how much water you have available, its flow and pressure. Start at the meter. It is usually near the curb buried in a meter box.

To find the meter’s size first look at the dial. Many meters have their size located directly below the gallon count. Sometimes it is stamped on the metal below the dial face. It will be something like ¾” or 1”, in most residential cases. Sometimes it’s not there or so dirty you can’t find it. In that case you have two choices. The easiest might be to simply call your water company and ask. They’ll have it on record. The other option, which is far from accurate but is safe for design, is to determine the size of the pipe leaving the meter and assume the meter is one size smaller. It is fairly common for the meter to be one size smaller than the feed pipe to the house. Typical water meter sizes are: 5/8”, 3/4”, 1”, 1 1/2”.

If you can’t read the pipe size on the pipe leaving the meter, don’t worry. DON’T GUESS. Also, don’t lay a ruler across it and use that measurement. If you have PVC you might be lucky enough to see the size printed on the pipe. If not, or if it’s not PVC, we have to measure. First, find a piece of string. Now, wrap the string around the pipe and mark the point where the string crosses. The length between the marks gives you the pipe size.
### Pipe Size Conversion Chart - Nominal Pipe Size to Circumference

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Copper Pipe</th>
<th>Galvanized Pipe</th>
<th>PVC Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>½”</td>
<td>2”</td>
<td>2½”</td>
<td>2½“</td>
</tr>
<tr>
<td>⁵⁄₈”</td>
<td>2¾”</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>¾”</td>
<td>2⅝”</td>
<td>3⁵⁄₁₆”</td>
<td>3⁵⁄₁₆“</td>
</tr>
<tr>
<td>1”</td>
<td>3⅛”</td>
<td>4⅛“</td>
<td>4⅛“</td>
</tr>
<tr>
<td>1¼”</td>
<td>4⁵⁄₁₆“</td>
<td>5³⁄₁₆“</td>
<td>5³⁄₁₆“</td>
</tr>
<tr>
<td>1½”</td>
<td>5⅛“</td>
<td>6”</td>
<td>6”</td>
</tr>
<tr>
<td>2”</td>
<td>6¾”</td>
<td>7⁵⁄₁₆“</td>
<td>7⁵⁄₁₆“</td>
</tr>
</tbody>
</table>

It is important to know what your pipe is made of. PVC tends to be white or grey (usually white), sometimes with lettering on the side and is plastic. Steel is grey and is magnetic, so that’s a quick test if there is any doubt. Copper will turn to a dirty green color over time and is not magnetic. Its connections will be soldered, so if you see silver at the joints you have copper. You may have what is commonly known as “flex” tubing. It can be either PEX or PE Tube. PEX is the stronger of the two and would usually be the one used for supply lines. It is white, might have PEX on the side. If there is any doubt then take a section to your supply house to see what you have and what fittings fit.
Teflon Tape and How To Use It

Teflon® tape (polytetrafluoroethylene, or PTFE), AKA plumber’s tape, is a thin film used to seal pipe threads. The tape is durable, flexible, and fills in the minor imperfections in the threads to seal leaks.

To use, hold one end of the tape against at the start of the pipe threads/end of pipe and start wrapping opposite of the direction of the threads, keeping the tape flat. Pull the tape tightly into the threads but not so tightly that the threads cut through. Keep going in a flat uniform manner until you come to the ends of the threads/pipe. Now thread the pipe in carefully and you’ll have a good seal.

You might want more than one layer but generally not more than two or three. If you are using drastically different materials, such as copper or brass to PVC, you may need extra but that is unlikely. Too much tape is as bad as too little. It will prevent a good seal. With the proper amount the pipe should thread together smoothly, sealing all gaps in the thread.

When do you not use plumber’s tape?

This tape is only effective on tapered threads as it uses compression to form the seal. Fortunately, the vast majority of the connections you make in irrigation will be with National Pipe Thread Tapered Thread, or NPT, and this tape will work well.

Many will tell you that brass to brass fittings are self sealing. In one manner they are but it takes an experienced professional to know which ones will work. You risk a leak if you are not sure you have the correct condition. Tape is cheap insurance. Brass fitting threads also tend to be extra sharp, especially on the smaller pieces, and may cut through the tape and ruin the seal. In this extra care is needed. In extreme cases you might need pipe dope but that is rare. The general connection involving brass in an irrigation system is with the backflow. Plumbers tape should work just fine there.
How to Program a Sprinkler System Controller / Timer

All too often, homeowners invest in topnotch sprinkler systems and timers – but never quite learn how to use them effectively. As a result, wasted water and other issues can abound. One of the primary benefits of using a first-rate sprinkler system controller is being able to create a watering schedule that keeps your plants and lawn looking great, without wasting exorbitant amounts of water. In this day and age, water conservation is a legitimate concern; besides, over-watering plants is a surefire way to damage them. If you’d like to enjoy the convenience of a sprinkler system, while maintaining an efficient watering schedule, the following information is sure to help.

The Basics

Before delving into the intricacies of programming a sprinkler system timer, it helps to familiarize yourself with the basics about how these devices work. Whether you’ve owned your timer for a while, or if you’ve just purchased one, it never hurts to learn everything from the beginning. That way, you create a sound foundation from which to base the rest of your sprinkler system programming. Learning the basic components and working your way up to more involved issues is also a smart way to keep confusion at bay.

So, you own a sprinkler system controller. That’s a great first step, but there’s still plenty to learn. We’ll begin by learning about the basic terms and features that are associated with modern sprinkler system timers.

Important Terminology to Know

Valve – This is probably the simplest thing to learn. Simply put, a valve is the part of the sprinkler system that receives signals from the timer. Those signals prompt the valve to open, letting water flow. A sprinkler system timer works by telling these valves when to open and operate. It is important to familiarize yourself with where each valve is on your property and to map out the types of plants and foliage that exist around each one. For best results, you should actually put pen to paper and draw a map that outlines where each valve in your sprinkler system is located.

Station – On the controller itself, the term “station” refers to the valves that are being controlled. In most situations, one station will correspond to one valve; however, for very large properties a station could control two or more valves in a given zone. Since most properties have one valve per zone you can think of the station on a time as the same thing as a zone or valve in a certain area of their property. When programming a sprinkler system timer, you are usually going to have to specify which stations to activate. This is convenient, of course, since certain stations require more watering than others – and some require a lot less.

Zone – While the region that gets watered is typically referred to as the “station” on a timer, most landscaping guides will refer to the actual area that’s receiving the water as the “zone.” For
example, a flower bed might be considered one zone; a large expanse of lawn might be another. When mapping out your yard and pinpointing its valves, then, it is smart to break things up into zones. This will simplify the process of programming your timer, since you’ll have a clear visual idea about the zones that each valve waters.

**Program** – Most timers have three programs available, and they are typically named program A, program B and program C. These programs hold the actual settings that control when and how long each station is watered. You might set program A, for instance, to water only the flowerbed areas and have them watered twice a day. Program B might be used to water only the lawn areas two or three days a week. Program C could be used to water plants or shrubs with a drip system, if you have one, a couple of times per week.

**Typical Timer/Controller Features**

The next step in programming a sprinkler system timer is learning all about its basic features. Be sure to familiarize yourself with the following terms before attempting to program your sprinkler system timer. Don’t forget to refer to the manual that was included with your sprinkler system controller to make sure that there aren’t any unusual features involved.

**Start Time** – The start time feature on a sprinkler system controller allows you to specify a time of day for a Program (A, B, or C) to start. Once it starts, it will begin irrigating the stations or zones that are associated with it. Once it works its way through all the stations or zones that are associated with the Program, the controller stops watering.

**Run Time** – This is sometimes called “Station Duration.” It is the time, in minutes, that a valve will remain opened. If you set a run time for fifteen minutes, then, the valve that it controls will remain open and water a zone for that length of time.

**Run** – When “run” is enabled, your scheduled programs will run as planned. As long as you have everything programmed to your liking, then, you’re usually going to want to have “run” enabled.

**Off/Stop** – If you need to prevent your programs from running, you’re going to want to toggle over to “off” or “stop.” There are many different reasons that you might want to do this; for instance, you may want to stop programs while you are programming your sprinkler system timer. Many people keep their systems on “off” during the winter months, too.

**Semi-Auto** – From time to time, a zone may require a supplemental watering. In that case, the semi-auto function is very convenient. This function allows you to run a specific program – A, B or C – whenever you want. For example, if your area has been having unusually dry or hot weather, you may want to use supplemental waterings to keep everything healthy.

**Manual** – This button lets you run a specific valve for whatever length of time you want. Also, on controllers that do not have a Semi-Auto button, this is used to manually turn on a zone or run a program (depending on the model controller) to water an area of the property if it looks a little dry. It is used to temporarily water the property at will without reprogramming the controller. It
can also be used to spot-check an irrigation system while performing repairs or during a Spring Check Up (looking for broken heads, misaligned heads, or other problems) of the sprinkler system.

**Getting Started**

Before you begin programming your sprinkler system timer and set up various programs for different zones, you’re going to need to make sure that your controller is set up properly. The most important part of doing that is ensuring that the current day and time are correct and accurate. Nothing can throw a kink in the works quite like having the incorrect day, date and time set on your timer, so take care to be as accurate as possible. It’s never a bad idea to periodically check your controller to ensure that it’s still set to the right time, too.

**Entering a Program**

Now that you have the right day and time configured, it’s time to enter a program.

1. Select the Program (A, B, or C) you want to program. For each program, you will need to set up the Water Schedule or “Days To Water”, Start Time, and Station Run Times.

2. Select the “schedule” function (Days To Water). Use it to select the specific days that you want the irrigation to run. An Example would be Monday, Wednesday, Friday, and Saturday. In some cases, you’ll need to specify the number of days between waterings.

3. Select “start time” and specify the time that you’d like the irrigation to begin. An example would be 5:45 am. If you have newly planted flowers, you may want to water a second time in the same day since the root zone may get dry by late afternoon. If you want to schedule a second start time at say 4:00 pm. Just remember that the second start time is for the Program you are setting up so all the zones you are watering on this Program will be watered a second time.

4. Select the “run time” or related function. Select the station of your choice and enter the run time for that valve. Continue selecting stations and entering run times until you have entered a run time for all the stations you will be watering on this Program.

   **Important:** do not set a run time for the stations that will not be watered using this Program.

   A general rule to follow if you have no idea how many minutes to water per station, you can start with the following times and either increase the time if you see you are not getting enough water or decrease the time if you see you are applying too much water:
3 – 10 minutes for spray head zones

20 – 40 minutes for rotor head zones

5. Program setup is complete once you have entered in the Water Schedule or “Days To Water”, Start Time, and Station Run Times.

6. To set up additional programs select a Program (A, B, or C) other than the one you just set up using the steps above. Repeat the steps listed above for each Program you want to run. You will want to set the Station Run Times to zero for the stations you already have running on another Program (A, B, or C). Only add Station Run Times for the stations you want to water using the Program you are setting up.

Please note that different sprinkler system timers have different controls and features. Some use dials, while others are 100% digital. Make sure to read through the specific instructions that have been outlined by the manufacturer.

**What’s the Deal with the Seasonal Adjust Button?**

Some late-model sprinkler system timers have seasonal adjust buttons. These buttons offer a convenient solution to unseasonal weather patterns by allowing you to make across-the-board adjustments to watering programs on a percentage-based basis. During the summer, for example, most people keep their seasonal adjust buttons set at 100% for 80-degree days. When the temperature shoots up to 90 degrees, the seasonal adjust button can be switched to 120%. In turn, run times will be lengthened by 20%. This saves you from the tedious hassle of having to reprogram everything – only to switch it all back a few days later. If your system has this feature, be sure to learn it and put it to good use when needed.

**Understand What Different Sprinkler Heads Do**

Different sprinkler heads are suitable for different purposes. When you understand what each type is best-suited for, you’ll be able to program your sprinkler system timer more efficiently.

**Spray Head**

**Spray Heads** – These sprinkler heads dispense high volumes of water in short periods of time. They are best suited for flat, even areas; do not use them on slopes. They are also suitable for small, hard-to-reach areas of lawn, and they are practical to use in areas where you’d like to avoid spraying a house, cars or the street.
Rotor Heads

**Rotor Heads** – When you need to water large expanses – especially of grass – rotor heads are the best option. They have a much lower application rate than spray heads do. Rotors are used to save labor on installation since they cover a larger area than spray heads so you can space them out much further apart. They are also a better choice for sloped areas or for areas that are made up of clay soils since they apply water at a slower rate than spray heads and thus help prevent water run off.

Drip Systems

**Drip Systems** – A drip system consists of a series of tubes that have small holes in them. These holes dispense small amounts of water to specific areas. This helps promote water conservation. Drip systems are best suited for flowerbeds, shrubs and groups of cacti since individual root systems can be targeted with ease.

**Putting a Sprinkler System Timer to Efficient Use**

You may know the basics about entering programs and setting up a sprinkler system controller, but that doesn’t mean that you know how to use one efficiently. The following tips, tricks and advice can help you make the most out of your sprinkler system timer.

**Group Programs for Maximum Efficiency** – Once you’ve mapped out the locations of all of the valves in your yard, you’ll be able to devise a sensible programming scheme. You should use one program to handle the needs of your lawn; it should control all of the valves that irrigate areas that consist primarily of grass. Another program should be used to irrigate sections of flowerbeds or ground cover. Another program should be used for drip systems.

**Invest in an Automatic Rain Shut-Off Device** - Some sprinkler systems come with automatic rain shut-off sensors included. If yours doesn’t, be sure to invest in one right away. These handy devices can be programmed to turn off your regularly scheduled programs whenever a specific amount of rain has fallen. Most people set these devices to kick in whenever a half an inch or more of rain has fallen. After all, it hardly makes sense to water your property when plenty of rain has recently fallen. This is a great way to avoid wasting valuable water and to reduce your water bill.
**Water Early in the Morning** – While you have full control over the times of day that each program runs, it is almost always best to perform irrigations during the early morning hours. During the middle of the day, the wind can carry off water droplets or the blazing sun can evaporate a lot of the water that is produced by your sprinkler system; in turn, the plants that its intended for don’t receive nearly as much of it. Wind can also significantly disrupt the spray pattern of the sprinklers causing wet and dry spots.

If you water during the early morning, you’ll be able to use a lot less water, which is another smart way to reduce your water bills and help the environment. Furthermore, watering at night promotes plant disease and fungus growth.

**Avoid Over-Watering** – If you think that it’s impossible to over-water plants, think again. Over-watering can be just as detrimental to plants as under-watering. By programming your sprinkler system controller the right way, you can provide the exact right amount of moisture for the various plants on your property without inadvertently over-watering them. The key thing to avoid is creating water run-off; if you see it happening, you know that you’re overdoing it.

**Get the Most Out of Your Sprinkler System Timer**

As you can see, programming a sprinkler system controller doesn’t have to be a mind-boggling experience. By learning about the way that your system is set up, familiarizing yourself with its valves, learning about the different types of sprinkler heads that are involved and understanding the needs of different types of plants, you can achieve a suitable and sensible irrigation schedule with a minimal amount of hassle.
What is an Irrigation Master Valve?

When considering installing an irrigation system, you might want to consider a master valve. A master valve is an electric valve installed at the supply point which controls water flow into the main piping system. When this valve is closed, water will not be supplied to the irrigation system.

A master valve will greatly reduce any water loss due to a leaky station valve because the leaky station valve can only leak while the master valve is providing pressure to the system. Also, if you damage the irrigation main line, a master valve will control water loss so the main can be repaired without shutting off the water supply.

A master electric valve is typically the same type of valve as you would use for your station valves, but rather than being installed downstream from your main line and connected to a station output in your controller it is installed upstream at the front of the main line and connected to the “master” or “pump” connection in your controller. Not all controllers support a master valve or pump - be sure to check the features before buying a controller.
How to Choose an Irrigation Controller

Irrigation controllers are essential components of a Irrigation Sprinkler System. When DIY sprinkler system, the following article can help you better understand how to choose, install and replace a controller / timer.

What is an Irrigation Controller?

Hunter Pro-C Timer

Irrigation controllers, also known as irrigation timers or lawn sprinkler system timers, are the nerve centers or brains of the sprinkler system. Sprinkler system timers send electric signals to the irrigation valves. The valves regulate the flow of water to the sprinkler system.

Irrigation Sprinkler System timers are the devices that allow you to set a watering schedule to meet your needs. You can set the days you want to water, the time of day you want the sprinklers to come on, and how long you want them to apply water.

Sprinkler system controllers may be mechanical, partly automatic, or fully automatic. Although irrigation sprinkler system timers are largely maintenance-free, the home or property owner might wish to upgrade and replace irrigation controllers or install irrigation controller parts or extra features. Sprinkler timer installation or replacement is very straightforward and easy and can be done by either the homeowner or by an irrigation professional.

How to Choose an Irrigation Controller / Timer

The only important decisions you need to make when selecting a controller / timer are as follows:

1. Controller mounting location: indoor or outdoor
2. Number of stations or zones – must be at least as many zones or areas your sprinkler system is broken up into.
3. Number of programs (1, 2, 3, or 4) – should have at least 2 or more programs to give you the watering flexibility you want or need. The programs on a controller are very different from the number of stations on a controller. This is explained below.

IMPORTANT: The rest of the features you can choose from on a controller are just for added benefits or increased flexibility.

Indoor vs. Outdoor models
Sprinkler system controllers come in a wide range of makes and models. Choose lawn sprinkler system timers depending on the size of the sprinkler system and the user’s needs. Lawn sprinkler system timers come in two different types: indoor models and outdoor models. Indoor sprinkler
system timers need to be sheltered from weather, and can be conveniently plugged directly into a 110-volt outlet. This is because they come with an external transformer as part of the plug-in cord that converts the 110-volts to 18 volts. Typical locations for mounting indoor timers are in the garage, building, covered patio, shed, pump house, closet, etc. Outdoor lawn sprinkler system timers are convenient, weather resistant, durable, and typically need to be hard wired for power instead of plugged into a 110-volt outlet. This is because the transformer is located inside the protective weather resistant cabinet and it is assumed that the electrical connection will need to be weather resistant also.

Outdoor controllers can be used as indoor controllers just by adding a pig tail (3 prong plug and power cord) to the power wires of the timer. People do this all the time to be able to get all the benefits of an outdoor timer with a weather resistant cabinet and typically all kinds of added features. An example of this is the Hunter ICC model controller which is one of Hunter’s best controllers. It has so many nice features that people will just add a pig-tail and make it an indoor timer.

**Controller Stations**

Typically, residential systems use irrigation controllers with 2 to 9 stations, while systems for commercial or public properties can have 32 – 48 stations or more. Each station regulates one zone or area of the lawn sprinkler system. When selecting irrigation controllers, know how many stations the system needs. Choose a sprinkler timer with extra stations, in case of later expansion.

**Controller Programs**

The number of programs a controller or timer typically has can range from 1 up to as many as 4. They are usually labeled as Program A, B, C, and D. Some controllers only have 1 program while most have at least 2 or more. A program is a set of watering instructions for stations that will run on the same days. When you set up Program A on the controller, you are setting the days you want to water, the time of day you want to start watering, and how long you want to water. If you have a controller with two programs, the lawn areas can be set up to be watered every day on one program and the flowerbeds and shrubs every other day on the second program. When a controller starts a program, it will go through the entire program before stopping or repeating the program.

**Types of Controllers – Mechanical or Solid-State (Digital)**

Some irrigation controllers are fully digital, including easy touch screen features. Digital sprinkler system controllers with basic features are suited to a more conservative budget. Other lawn sprinkler system controllers have an array of features and options for convenience and ease of operation.

Mechanical sprinkler system timers use manually-operated sliders and switches for programming. An electromechanical controller uses both an electric clock and mechanical switching. That is to say, they are made of a motor, wheels, dials, gears, and pins. These controllers are typically, easy to understand how to operate and program, and are less susceptible to power spikes and surges, but are much more limited in features than solid-state digital irrigation controllers.
Solid-State controllers have digital readout screen, have no moving parts, and use integrated circuits for the clock, memory and control features. These controllers are adaptable, offering many more features at a reasonable cost. More advanced Solid-State controllers such as Smart Controllers can adjust the watering schedule automatically throughout the year. Still other controllers operate solely on battery power, for areas with limited or no electricity. Solar-powered controllers are also available.

**Features Available on a Controller**

Some controllers come fully loaded with features for efficiency and convenience of operation. In others, extra features may be optional. Key features available on a controller can include:

- **Clock and calendar settings**
  The user can program watering times, control watering cycles, and make seasonal adjustments.

- **Manual start and manual station operation**
  The user can operate the stations or start the automatic cycle without affecting the programmed start time. This is helpful when you need to do some maintenance to your system. This feature makes it easier to check for leaks, misaligned or broken sprinkler heads and even perform basic tune-ups steps such as adjust spray patterns and replace nozzles.

- **Master Switch**
  The master switch overrides the automatic functions of the stations.

- **Master Valve Control**
  The master valve prevents flow to the system, in case of water problems or system failure.

- **Station Omission**
  The user chooses which stations operate, and which do not.

- **Pump Start Lead**
  This turns on a pump start relay whenever a station activates, to combine irrigation and pump control. A Pump Start Relay is an electronic device that uses a signal current from the irrigation controller to activate a pump to provide water to the irrigation system. Never connect the controller directly to a pump as damage to the controller will result.

- **Rain Sensor**
  A rain sensor shuts down the irrigation system if it detects rain. The purpose of a rain sensor is to stop watering when precipitation is sufficient. Most controllers allow for a sensor to be connected directly to the controller and allow you to easily override the sensor by using a Rain Sensor Bypass switch on the controller.

- **Battery backup**
  The controller reverts to battery power in case of power interruption or outage. The battery typically will just allow the timer to maintain the time, date, and watering schedule. On some controllers it allows the user to program the controller without AC power. IMPORTANT: watering will not occur without AC power. The battery only keeps the time, date, and watering schedule in memory until the AC power is restored or the battery dies.

- **Non-Volatile Memory**
  The controller retains its program data without a battery, even if the power fails. The non-volatile memory allows the timer to maintain the time, date, and watering schedule indefinitely. IMPORTANT: watering will not occur without AC power.

- **Delay**
  The delay feature allows time for valves to close fully in one zone, before opening the valves in another zone.
How to Install a Sprinkler Timer

Irrigation Instructions on How To Install A Sprinkler System, Irrigation System Supplies

Tools Needed to Install Irrigation Controller / Timers

1. 3/8” electric drill, cordless or with cord
2. Masonry bit, if drilling holes in stucco.
3. Metal center punch. If drilling into wood, the punch isn’t necessary.
4. Wood type drill bit – to drill holes through the timer cabinet
5. Black sharpie or felt-tipped marker
6. A hammer
7. A level
8. Screws, with matching plastic wall anchors
9. Screwdriver

How to Install, Wire, and Set Up a New Irrigation Controller

1. Decide on the location for the sprinkler controller. Consider factors such as power supply, whether the sprinkler timer is an indoor or outdoor model, whether it will plug into an outlet or needs to be hard wired. Also consider convenience of operation, and ease of access for the user.
2. Unpack the timer. Some hardware and supporting documents will be included for the installation.
3. Remove the clock/timer face from the controller. The face should snap out easily. Look for clips or plastic tabs along the front or sides of the unit. Also detach the ribbon connector. If desired, remove the cabinet door by taking out the steel pin connecting the door to the main cabinet.
4. For extra stability, drill extra mounting holes through the back of the cabinet. Irrigation controllers usually come with pre-drilled holes or mounting hardware in the back, so this step is optional.
5. If hard wiring the timer, cut electric power. Turn off the breaker to the wires. Double check the wires to be sure the electricity is off, by using a volt-meter or ticker. The volt-meter gives off an alarm if it detects electricity in a line. An active electrical current can cause injury to the user, or throw off sparks that can damage the irrigation controller.
6. Mount the cabinet at a comfortable height, usually about eye level. Place the cabinet against the wall, and use the level to check that it is even. Use the felt tipped pen to mark the wall through the holes in the back of the cabinet.
7. If drilling into stucco, use the metal center punch. Line the punch up to the marks on the wall, and give it a firm whack with the hammer to make a small indentation in each mark. This keeps the stucco drill bit centered and stable. Drill holes into the wall at the marks.
8. Put the plastic inserts into holes. Tap them flush against the wall with the hammer.
9. Using screws, mount the timer cabinet to the wall. Connect the station wires. Make notes of which wires are responsible for each zone or valve of the sprinkler system, to avoid guesswork in the future.
10. Re-mount the timer face and re-attach the ribbon connector to the board. Do not turn on the power until these steps are complete. Replace the cabinet door. The controller is now ready for programming and operation.
Wiring the Controller to the Valves

1. Purchase sprinkler or irrigation wire. Buy one strand more than the number of zones desired. Usually, the white wire is the common wire, and the others will lead to individual sprinkler valves.
2. Turn off the power to the controller. Be sure to follow the manufacturer’s instructions when attaching wires. Look for a terminal on the controller that says “C”. Attach the white or common wire.
3. Run a wire from the solenoid on each zone valve back to the controller. If the valves are underground, the wire will run alongside the PVC pipe leading to the valve. Be sure the connections are waterproof. Water leakage will damage the solenoid.
4. Each wire will regulate a different zone from a station on the controller terminal. Delegate the stations as desired and attach the individual wires. Make a written plan or diagram of the setup, to avoid confusion in the future. One can also mark the wires as Zone 1, Zone 2, and so on.
5. Do not turn on the power until wiring is complete.

How to Replace an Existing Irrigation Controller:

If you already have a controller that is giving you problems and find that you need to replace it with a new one, let me reassure you that it is very easy to replace a controller and most any homeowner or irrigation repair person can handle this task. First, if possible, it makes your job easier if you can write down all of your existing programming from the old controller. Specifically, you want to write down the specific days scheduled for watering, the start times and how long each zone is scheduled to be watered. You will need to use this information to program the new controller. If the old controller is completely dead and you can not get this information, no worries, as you can program the new controller to water a few days a week and the rotor zones for 20 minutes and the spray head zones for 5 to 8 minutes each time they come on. A good start time is 4:00 or 5:00 am so that all the watering is completed before you need to start using water in the house in the morning. Then you can adjust these settings later as you find that the yard is getting watered too much or not enough.

Make sure to unplug your transformer from the wall, if you have an indoor system, or turn off the power to the timer at the breaker box, if you have an outdoor system. Use that volt-meter to verify the power is not reaching the controller. The next step is to label each of the control valve (hot) wires on the old timer. Label them according to the zone they are connected to, zone 1, zone 2, zone 3, etc. Also label the common wire connected to the common connection and the pump start wire if you are using a pump. Now you are ready to disconnect the wires.

If possible, buy the same model and brand as the controller that was already in the system. If you can not buy the same model, that’s ok, just get one that has the correct number of stations or zones that you had on your old timer and make sure you get all the features you want. Now is a good time to upgrade to a better more feature rich timer. Take the old controller out and mount the new one on the wall. Reconnect your wires as they are labeled and reprogram your controller with your watering schedule. Turn the controller on and make sure all zones are working properly.
Differences in installing an indoor controller and an outdoor controller

Sprinkler system controllers come in interior or exterior models. Indoor sprinkler system timers plug easily into an electric outlet. The interior models have a power supply or transformer that converts 110/120 volts of standard house power to the 18-24 volts required for sprinkler system operation. Exterior sprinkler system controllers are housed in sealed weather-resistant cabinets. The exterior controller has a transformer inside the cabinet, and must be hard wired into the power supply.

Indoor irrigation controllers can also be installed outside. Weather-resistant cabinets are available separately to convert indoor controllers to outdoor use.

How to install a controller when a pump is also going to be used

1. A pump brings water from a well, pond or nearby water source to the sprinkler system. When using a pump instead of a municipal water supply line, choose a sprinkler timer that will work best with the pump.
2. Electric sprinkler system controllers can turn the pump on and off at pre-programmed times. Most irrigation controllers have a pump circuit built in. The timer uses a voltage relay to start and stop the pump. The relay allows the controller, which operates on 18-24 volts, to communicate with the pump, which uses standard house voltage (110/120v).
3. Do not connect the irrigation controller to an existing relay. If the pump already has a starter circuit with relay, the user will need to install a new one for the controller.
4. To hook up the pump, connect the wires from the pump start switch to the pump start terminal(s) on the controller. Some irrigation controllers feature zone-by-zone programming for more effective pump operation.
5. Use a flow switch with the sprinkler timer relay. The flow switch turns off the pump if there is no water flow, preventing the pump from overheating in case of a system malfunction or water supply interruption.
6. A delay feature is helpful when installing an irrigation controller with pump. The delay allows slow-closing valves to shut down completely in one zone, before the next zone starts operating.
7. Check with local authorities to be sure of bylaws and water codes. Some areas have regulations regarding the operation of pumps and lawn sprinkler systems.

Items to Consider Adding to the Controller

- **Extra Stations**
  Many lawn sprinkler system timers can be adapted to add extra stations, in case of expansion or amendments to the lawn sprinkler system.
- **Remote Control**
  Remote control allows the user to operate indoor or outdoor sprinkler system controllers from a distance. If the system doesn’t come with a remote, the user can add a remote control transmitter & receiver to most lawn sprinkler system controllers. The remote control comes in handy if the user wants to do work or maintenance on the sprinkler system, or operate the controller from a remote location. It makes spring checkups and maintenance much easier. You can turn zones on and off without walking back and forth to the timer.
- **Computer Control**
  The user can control the sprinkler timer and features from a computer.
• **Weather Devices**
  Some irrigation controllers have built-in rain sensors. If not, adding a rain sensor or other weather device to the controller is a practical option for most home and property owners. Weather devices also sense outdoor temperature to guard against freezing. A solar power converter is a handy add-on feature available in some sprinkler system controllers.

• **Mounting Pedestal**
  Instead of mounting the sprinkler timer to the wall, the user has the option of mounting the controller on a stand-alone pedestal. Some irrigation controller pedestals include a separate wiring board.

• **Rain shut off devices or other weather devices**
  Rain sensors and rain shut-off devices automatically adjust the system’s function when rain is detected. Some sprinkler system controllers feature seasonal adjustment options. Other weather devices include wind sensors, which shut down the system in case of high winds, or temperature-sensitive features to regulate the function of the lawn sprinkler system.
Types of Irrigation Valves

Irrigation Sprinkler System Guide
Irrigation valves or lawn sprinkler valves are an essential component of lawn sprinkler systems. They control the flow of water in lawn sprinkler systems. Sprinkler system valves come in a variety of models, including below ground inline valves and above ground anti-siphon valves.

Available in solid brass or durable plastic, sprinkler valves operate from a manifold above or below ground to regulate water flow to the lawn sprinklers.

Lawn sprinkler systems may be manual or automatic. Automatic lawn sprinkler systems consist of the controller / timer, the sprinkler valves, the pipes, and the lawn sprinklers. Each valve controls a different zone, or area, of the lawn sprinkler system. The controller sends electric low voltage (24 volt AC) signals to the valves, telling them to open or close.

Sprinkler valves come in many different styles. Globe or angle irrigation valves work with a separate backflow preventer, and anti-siphon valves have the backflow preventer built-in. Rain Bird valves, Toro valves, Hunter valves, Irritrol valves and Weathermatic valves are all reliable, well-known products that, with proper maintenance, will last for many years.

Irrigation Valves – Types of Valves and What They Are Used For Shut-off Valves

Emergency shut-off valves stop the flow of water to the irrigation system. If repairs are needed to the sprinkler system valves or any other part of the irrigation system, the shut-off valve prevents the need to turn off the entire water system to the house or whatever else the water feeds.

Emergency shut off valve: You should install this sprinkler system valve as close to the water source as possible and should be the same size as the pipe you are installing it on. If you do not install this valve, you will have to shut the water off to the entire house when you want to make repairs or work on the irrigation line. You only need to install one of these shut off valves for your irrigation system and it will either be installed underground in a valve box or in the basement depending on where your water supply connection is located.

If you are using a water meter from the city as your source of water, it is best to tee off the pipe coming out of the water meter (the one headed to feed the house) as close to the meter as
possible and use the tee to start the water supply to the sprinkler system. In this case, you would install the shut off valve close to the tee on the line headed to feed the sprinkler system. Some people will put the tee close to the meter but then install the shut off valve just before the backflow device which may be installed on the side of the house. If you are in an area that freezes and you will be using the basement water supply piping as your sprinkler system water supply, install the shut off valve in the basement on the piping before the backflow device.

The most popular valves used for this purpose are the gate valve, ball valve, disc valve or butterfly valve. The gate valves are the most inexpensive and tend to NOT Close completely plus they are typically metal and corrode quickly making it difficult if not impossible to use. Your best bet is to use a PVC ball valve (highly recommended) since they are a more reliable choice. They close completely and they do not corrode or rust which means you should always be able to open and close them easily even when buried under ground in a valve box.

Control Valves (as known as Zone Valves)

Irrigation control valves are used to turn the irrigation system on and off and there are two different types to choose from:
1.) Globe and Angle Valves
2.) Anti-Siphon Valves

The globe and angle valves come in any size and are usually installed under the ground or in a vault or valve box. Since there is not a backflow preventer attached as part of the valve, you will need to add that separately. This is the most common type used in sprinkler systems. However, you may choose to use the anti-siphon valve, which comes only in 3/4- and 1-inch sizes and comes complete with a backflow preventer. The anti-siphon valve absolutely must be installed above the ground and must also be 6 inches higher than that of the highest sprinkler head.

Valves come in brass and plastic; the most common ones used today are the plastic ones. The brass valves will ultimately last longer if installed in the sunlight. Both types are reliable for an automatic system, but for manual systems the manual brass valve is the best choice because it lasts much longer. Valves today are fairly maintenance free.

As for pressure losses and valve size, the automatic valves should be sized based on the manufacturer’s flow range chart and will not necessarily be the same size as the pipe. However, it is more common that it will be the same size as the pipe it is installed on. A manual valve is much more adaptable than the automatic and you do not have to depend on electricity to power it, rather it is done manually, hence the name. A manual irrigation control valve needs to be either an angle or globe type with replaceable rubber seals and not the gate type as the gate valve is not made to be opened and closed regularly.

Above Ground Anti-Siphon Valves

Anti-siphon valves have a built-in backflow preventer to keep irrigation water from washing back into the household’s main water supply. Use Anti-Siphon valves in locations where the use of a pressure vacuum breaker (PVB) or double check valve is not required by city codes. Some
areas of the country, such as in California and Arizona, require backflow prevention for every zone. Check your local city codes to determine what type of valves are required. The Anti-Siphon valve is a combination valve that has an atmospheric vacuum breaker and an electronic control valve all in one unit. It provides backflow prevention on every zone, saving costs by eliminating the need for a separate backflow preventer. Anti-Siphon valves are installed above ground and will prevent backflow if properly installed. Anti-Siphon valves should always be installed at least 6” above the highest head on the valve line, and should never have another valve installed further down the line from the main valve.

**Below Ground Inline Valves**

These valves are often globe valves or angle valves. Inline valves are installed underground, protected by a valve box. Below ground inline valves require a separate backflow preventer, installed to meet local bylaws and regulations. However, the great thing about inline valves is that they are typically less expensive than anti-siphon valves and you can install them in the middle of each zone (or section) of your sprinkler system which keeps the pressure loss in the zone more balanced and uniform. Furthermore, you save money on pipe since you end up with one mainline traveling through your yard supplying all your valves instead of having multiple runs of pipe in the same trench heading from the anti-siphon valve manifold to each zone. Plus you only need one backflow preventer device protecting the whole sprinkler system instead of paying for one on each anti-siphon valve. Using a single backflow device with inline valves is a better way of installing your system and it will last longer than the anti-siphon valve plastic backflow device which relies on gravity and has no other parts to assure it functions properly. One other important note: anti-siphon valve backflow valves cannot be tested to see if the backflow prevention is functioning, however, backflow devices purchased separately to be used with inline valves can be tested to assure they are functioning correctly. Using inline valves is a more professional way of installing your sprinkler system.

**Globe Valves**

Globe valves once had a spherical body, but modern globe valves have changed in shape, and only the name remains. Water flows through the valve without changing direction. The two halves of the valve body are separated by an internal baffle. A movable plug, or disc, screws in to shut off the valve. In manual globe valves, the plug connects to a stem which operates by hand wheel. In automatic globe valves, the stem is smooth.

**Angle Valves**

Named for their angular design, angle valves direct the flow of water at a right angle to the valve. Water flows into the valve and then changes direction 90 degrees.

**The Valve Manifold**

The manifold is a group of control valves attached to a pipe. Water enters the manifold from the main water supply line. The water is then routed through the control valves. The valve manifold may be below or above ground.
To build the valve manifold, use a length of PVC pipe. Space the valves about three to six inches apart. The number of valves determines the overall length of the manifold pipe. Include an extra connection or two, for possible expansion to the system later. Save time and work by purchasing a ready-to-install manifold kit, which includes the sprinkler valves and all necessary parts and instructions. Many manifold kits have a flow control feature, to help conserve water.

**Valve Boxes**

A valve box is a plastic cover that protects the valves and wiring from damage and debris. Above ground, the valve box also protects the valves and manifold piping from harsh sunlight and inclement weather, or damage by accident, animals or vandalism.

**Backflow Prevention Devices**

Backflow prevention devices will prevent irrigation water from lawn sprinkler systems from backing up into the drinking water. Irrigation water may contain contaminants such as pesticides and other chemicals, as well as waste products and dirt. While these elements don’t harm the lawn, they create health risks in public or household drinking water.
Site information page, graph paper and charts
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Scale of drawing:</strong></td>
<td><strong>5. Water Pressure &amp; Flow Readings:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>inch = _____ feet</strong></td>
<td><strong>Static Water Pressure _____ PSI</strong></td>
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<td></td>
<td>or</td>
<td>Gallons-Per-Minute: @ 40 PSI _____</td>
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<tr>
<td></td>
<td><strong>block = _____ feet</strong></td>
<td>@ 45 PSI _____</td>
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<td></td>
<td></td>
<td>@ 50 PSI _____</td>
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<td><strong>2. Water Meter Size:</strong></td>
<td><strong>6. Soil Information:</strong></td>
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<tr>
<td></td>
<td>□ 5/8 inch</td>
<td>□ Clay</td>
</tr>
<tr>
<td></td>
<td>□ 3/4 inch</td>
<td>□ Loam</td>
</tr>
<tr>
<td></td>
<td>□ 1 inch</td>
<td>□ Sand</td>
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<tr>
<td></td>
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<td><strong>3. Water Supply Line Type:</strong></td>
<td><strong>7. Install Timer:</strong></td>
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<tr>
<td></td>
<td>□ Copper</td>
<td>□ Indoors</td>
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<tr>
<td></td>
<td>□ Galvanized</td>
<td>□ Outdoors</td>
</tr>
<tr>
<td></td>
<td>□ PVC</td>
<td>Notes:</td>
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<td><strong>4. Water Supply Line Size:</strong></td>
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<td>□ 3/4 inch</td>
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<td></td>
<td>□ 1 inch</td>
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</tr>
<tr>
<td></td>
<td>□ 1-1/4 inch</td>
<td>Sediment</td>
</tr>
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<td></td>
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<td>Notes:</td>
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</table>
Charts and More!

Irrigation design is simpler than you think but it is a game of numbers. Flow rate, pressure, slope, head spacing and more all figure into a good design. Fortunately someone else has already done all the hard work for you. Even if the chart has hundreds of numbers you usually only need one. Finding the one you want is always logical and follows step by step design techniques.

Having a hard time figuring out how to measure a slope or calculating how many zones you need? Not a problem, below are some helpful tools to help you figure it out.

Determine the Percentage of Slope

Divide the measure of height by the measure of length and multiply by 100. Don’t worry about exact inches. Round to nearest quarter foot. For example, 12’ 1” = 12’, 13’7” = 13’6” or 13.5 feet.

Example above: 2 divided by 14 times 100 = 14.3%

<table>
<thead>
<tr>
<th>Timer to Valve Wire Sizing Chart</th>
<th>Valve Inlet Size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gauge</strong></td>
<td><strong>Maximum Distance</strong></td>
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<tr>
<td>18</td>
<td>1000 ft</td>
</tr>
<tr>
<td>14</td>
<td>1450 ft</td>
</tr>
<tr>
<td>10</td>
<td>1750 ft</td>
</tr>
<tr>
<td>10</td>
<td>1750 ft</td>
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<tr>
<td>PVC Pipe / Schedule 40</td>
<td>PVC Pipe / Class 200</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>&gt; 0-4</td>
<td>1/2&quot;</td>
</tr>
<tr>
<td>&gt; 4-8</td>
<td>3/4&quot;</td>
</tr>
<tr>
<td>&gt; 8-12</td>
<td>1&quot;</td>
</tr>
<tr>
<td>&gt; 12-22</td>
<td>1 1/4&quot;</td>
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<tr>
<td>&gt; 22-30</td>
<td>1 1/2&quot;</td>
</tr>
<tr>
<td>&gt; 30-50</td>
<td>2&quot;</td>
</tr>
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</table>

Use this chart to size your pipe according to GPM needed for each zone.

<table>
<thead>
<tr>
<th>PVC Pipe / Class 125</th>
<th>Poly Pipe / Galvanized Pipe</th>
<th>Valve Size</th>
<th>Max GPM Flow</th>
<th>Pipe Size</th>
<th>Valve Size</th>
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<tr>
<td>-</td>
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<td>-</td>
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<td>1/2&quot;</td>
<td>1/2&quot;</td>
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<td>&gt;0-10</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>&gt; 22-30</td>
<td>1 1/2&quot;</td>
<td>1 1/2&quot;</td>
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<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>&gt; 35-50</td>
<td>2&quot;</td>
<td>2&quot;</td>
</tr>
</tbody>
</table>

Use this chart to size your pipe according to GPM needed for each zone.
# PVC Schedule 40 IPS Plastic Pipe

Velocity of flow values are computed from the general equation:

$$ V = \frac{400}{\sqrt{d}} $$

Friction pressure loss values are computed from the equation:

$$ h_f = 0.283 \frac{V^2}{2g} $$

## PSI Loss Per 100 Feet of Tube (PSI/100 FT)

| Size (IPS) | 1/8" | 1/4" | 3/8" | 1/2" | 3/4" | 1" | 1 1/4" | 1 1/2" | 2" | 3" | 4" | 5" | 6" | 8" | 10" | 12" | 16" | 20" | 25" | 30" |
|-----------|------|------|------|------|------|----|--------|--------|----|----|----|----|----|----|------|------|-----|-----|-----|
|           | 0.80 | 1.50 | 1.31 | 1.60 | 1.90 | 2.37 | 2.00 | 2.00 | 2.68 | 3.75 | 5.00 | 6.25 | 7.50 | 8.75 | 10.00 | 12.50 | 16.00 | 20.00 | 25.00 |

### FRICTION LOSS CHARACTERISTICS

Sprinkler System Design

Note: Stacked areas of chart indicate velocities over 5' per second. Use with Caution.
### WATER METERS

**AWWA STANDARD PRESSURE LOSS: (PSI)**

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<th>Flow GPM</th>
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<th>Nominal Size</th>
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### PIPE FITTINGS

**Expressed as Equivalent Footage of Pipe**

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<th>1 1/4</th>
<th>1 1/2</th>
<th>2</th>
<th>2 1/2</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>8</th>
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<td>1.2</td>
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<td>4.0</td>
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<td>1</td>
<td>1.5</td>
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<td>2</td>
<td>2.5</td>
<td>3</td>
<td>4</td>
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<td>11</td>
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<tr>
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<td>4</td>
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<td>20</td>
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<td>Elbow, 90°</td>
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<td>2.5</td>
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<th>2.5</th>
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<th>4</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>11</th>
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<td>Run of St. Tee</td>
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<td>5</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>11</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td>Tee, Side Outlet</td>
<td>7</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td>18</td>
<td>24</td>
<td>30</td>
<td>36</td>
<td>45</td>
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<td>9</td>
<td>11</td>
<td>14</td>
<td>17</td>
<td>24</td>
<td>35</td>
</tr>
<tr>
<td>Elbow, 90°</td>
<td>3.5</td>
<td>4.5</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>11</td>
<td>14</td>
<td>17</td>
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<td>34</td>
</tr>
<tr>
<td>Elbow, 45°</td>
<td>1.5</td>
<td>2</td>
<td>3</td>
<td>3.5</td>
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<td>5</td>
<td>7</td>
<td>8</td>
<td>10</td>
<td>16</td>
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</tbody>
</table>
The following chart represents the maximum wire length recommended for valve installation. Recommendations are based on wire sizes used for valve field (control) wires and common wires. All lengths listed assume the use of one Nelson valve per zone and have been proven to operate the solenoid despite minimal voltage and high in-rush (worst case scenario).

To use chart, find the gauge of your common wire and the gauge of your control wire. The number that joins the two gauge sizes on the chart is the maximum number of feet of wire that can be used for installation. For example, if you use a 12 gauge common wire combined with an 18 gauge wire to control the valves, a 1,504 foot wire run is acceptable. (Based on a 20 VA transformer)

<table>
<thead>
<tr>
<th>Size (ft)</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>22</th>
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<tbody>
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<td>18,461</td>
<td>13,333</td>
<td>9,600</td>
<td>6,522</td>
<td>4,332</td>
<td>2,721</td>
<td>1,807</td>
<td>1,159</td>
<td>729</td>
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<tr>
<td>18,462</td>
<td>15,000</td>
<td>11,429</td>
<td>8,571</td>
<td>6,030</td>
<td>4,110</td>
<td>2,632</td>
<td>1,767</td>
<td>1,143</td>
<td>723</td>
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<tr>
<td>13,333</td>
<td>11,429</td>
<td>9,231</td>
<td>7,273</td>
<td>5,357</td>
<td>3,785</td>
<td>2,495</td>
<td>1,705</td>
<td>1,116</td>
<td>712</td>
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<tr>
<td>9,600</td>
<td>8,571</td>
<td>7,273</td>
<td>6,000</td>
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<td>1,027</td>
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<td>2,721</td>
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<td>1,796</td>
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<tr>
<td>1,807</td>
<td>1,767</td>
<td>1,705</td>
<td>1,624</td>
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<td>1,347</td>
<td>1,137</td>
<td>939</td>
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<td>1,159</td>
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<td>951</td>
<td>842</td>
<td>728</td>
<td>594</td>
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</tr>
<tr>
<td>729</td>
<td>723</td>
<td>712</td>
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<td>589</td>
<td>531</td>
<td>456</td>
<td>370</td>
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The maximum PR values listed below are as suggested by the United States Department of Agriculture. The values are average and may vary with respect to actual soil and ground cover condition.

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<tr>
<th>Soil Texture</th>
<th>0 to 5% slope</th>
<th>5 to 10% slope</th>
<th>10 to 15% slope</th>
<th>15% and up slope</th>
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<td>15% and up slope</td>
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<td>8.50</td>
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<tr>
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<td>4.00</td>
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<td>3.00</td>
<td>3.50</td>
<td>4.00</td>
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<tr>
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<td>2.50</td>
<td>3.00</td>
<td>3.50</td>
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<tr>
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<td>1.50</td>
<td>2.00</td>
<td>2.50</td>
<td>3.00</td>
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<tr>
<td>Sandy clay loam</td>
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<td>1.50</td>
<td>2.00</td>
<td>2.50</td>
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<tr>
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<td>1.00</td>
<td>1.50</td>
<td>2.00</td>
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<tr>
<td>Sandy clay loam</td>
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<td>0.50</td>
<td>1.00</td>
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### Precipitation Rates

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<th>Formula</th>
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<tr>
<td>U.S.</td>
<td><strong>Equilateral Triangular Spacing</strong>&lt;br&gt;P.R. = (GPM of 360) x 96.3 / (Head Spacing)^2 x .866</td>
</tr>
<tr>
<td>Metric</td>
<td><strong>Square/Rectangular Spacing</strong>&lt;br&gt;P.R. = (GPM of 360) x 96.3 / Head Spacing x Row Spacing</td>
</tr>
<tr>
<td></td>
<td><strong>Horsepower</strong>&lt;br&gt;H.P. = GPM x Total Dynamic Head / 3,960 x Pump Efficiency (expresses as a decimal)</td>
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### Station Run Time

<table>
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<th>Formula</th>
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<tbody>
<tr>
<td>(min/hr)</td>
<td><strong>S.R.T. = Total Weekly Req’d (inch/wk) x 60 (min/hr) / Precipitation Rate (in/hr)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>S.R.T. = Total Weekly Req’d (mm/week) x Precipitation Rate (mm/hr)</strong></td>
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### Pipe Velocity

<table>
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<th>Formula</th>
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<tr>
<td>(ft/sec)</td>
<td><strong>V. = 0.408 x Flow (GPM) / (Inside Pipe Diameter in Inches)^2</strong></td>
</tr>
<tr>
<td>(m/sec)</td>
<td><strong>V. = 1273.2 x Flow (liters/sec) / (Inside Pipe Diameter in Millimeters)^2</strong></td>
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</table>

Do not exceed 5" per second.

### Conversion Factors

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<th>Multiply By</th>
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<tr>
<td></td>
<td>acres</td>
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<td>horsepower</td>
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</tr>
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<td>liters/minute</td>
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<td></td>
<td>meters³/hour</td>
<td>liters/second</td>
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<table>
<thead>
<tr>
<th>To Convert</th>
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<th>To</th>
<th>Multiply By</th>
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<td></td>
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<td></td>
<td>bars</td>
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<tr>
<td></td>
<td>PSI</td>
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</tr>
<tr>
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<td>meters/second</td>
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<td>meters³</td>
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<tr>
<td></td>
<td>gallons</td>
<td>liters</td>
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