Software is the Future of Irrigation Design

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Abstract. *The future of irrigation design is in software, with highly-specialized CAD tools that dramatically speed the process of producing irrigation plans.*
The first, and most crucial element of irrigation design software, is the equipment database: all the varied manufacturers, with new and updated models, and wildly varying performance specifications. Further, all these pieces of equipment have to be matched with appropriate symbols to represent them on the plan. There needs to be tools to rapidly and easily place sprinklers and equipment, calculate their flow and pressure needs, indicate how they are to be piped, generate a legend, and most importantly, perform the flow hydraulics calculations to determine thie sizes of pipes required.
Programs such as Land F/X offer this, as well as advanced error-checking, resulting in the production of a plan in a fraction of the time it normally takes, and verified accurate to a degree never possible before.

Keywords. Irrigation software CAD

Why Use Technology?

I'd like to start with a brief story about the adoption of technology. A good example of this would be to go all the way back to the late 1800's. Those times saw the heyday of inventions, yet for the railroad industry, advancements in railcar coupling mechanisms and automatic brakes were not adopted. Even after a tragic crash that killed 29 passengers, it still took an act of Congress to mandate the use of such simple safety mechanisms. And after all the complaining from the railroad industry that such standards would bankrupt them, the new technology saw them benefiting with record profits and much-increased efficiency and safety after adopting the innovations.

In the same vein, some irrigation designers claim that they can produce a design quicker by hand than with software. While this may or may not be true, the indisputable gains from using software are in areas such as error-checking, revisions, redesigning the system for differing requirements or equipment, all done nearly instantly and perfectly accurate.

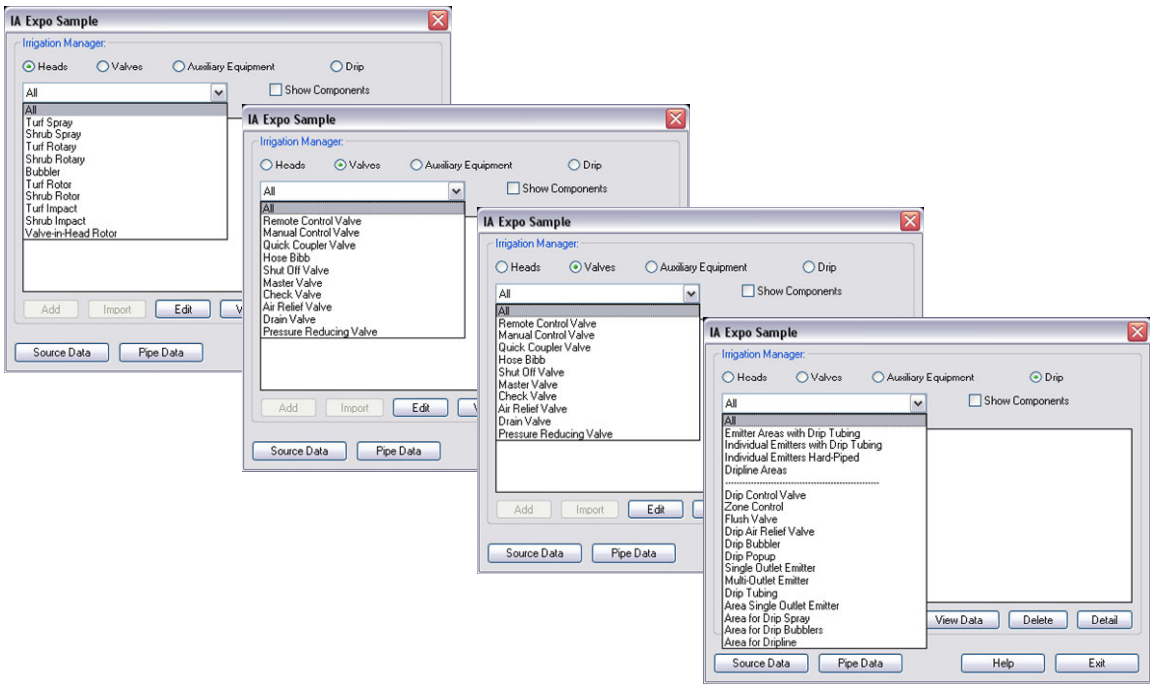
There are a number of irrigation software design programs out there – I am going to demonstrate the one I am most familiar with – in fact so familiar with it, I wrote every line of code in there. But let's suffice it to say that there are several programs which accomplish the same basic goal – that of the computer aiding the irrigation designer in the management of the many technical calculations necessary. Let me show you how computer software can automate and radically speed up the typical steps in developing an irrigation plan.

Selecting Equipment

The first stop is in equipment selection. Many irrigation designers can fall into the habit of continuing to specify the same equipment over and over. One reason for this, of course, is because they have seen the equipment in action and think it's a good product, but, more often than not, it's because it is too difficult to design with equipment they are not used to and don't have the performance data memorized.

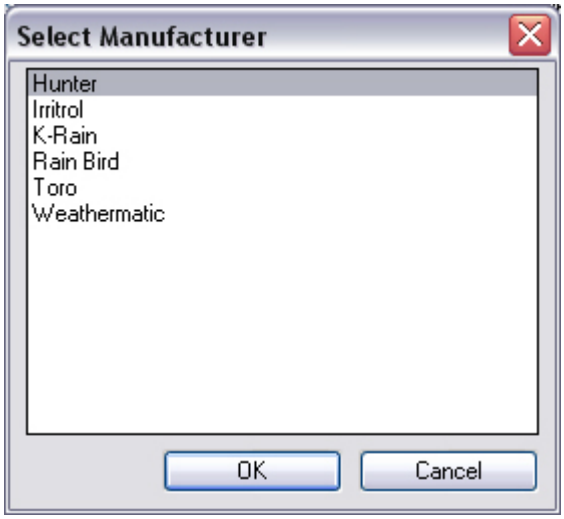
This is just one of the many things that software can help with. These software companies spend vast hours updating their product with the latest models from each manufacturer, folding them into the system, logging the vast performance-related data, and creating graphical symbols to represent each piece of equipment.

Correctly designed software can allow you to quickly place any type of equipment, and not bother you with data and symbol requirements. First, is just managing the many various types of irrigation equipment, broken up into four overall categories: Heads, Valves, Auxiliary Equipment, and Drip Irrigation.



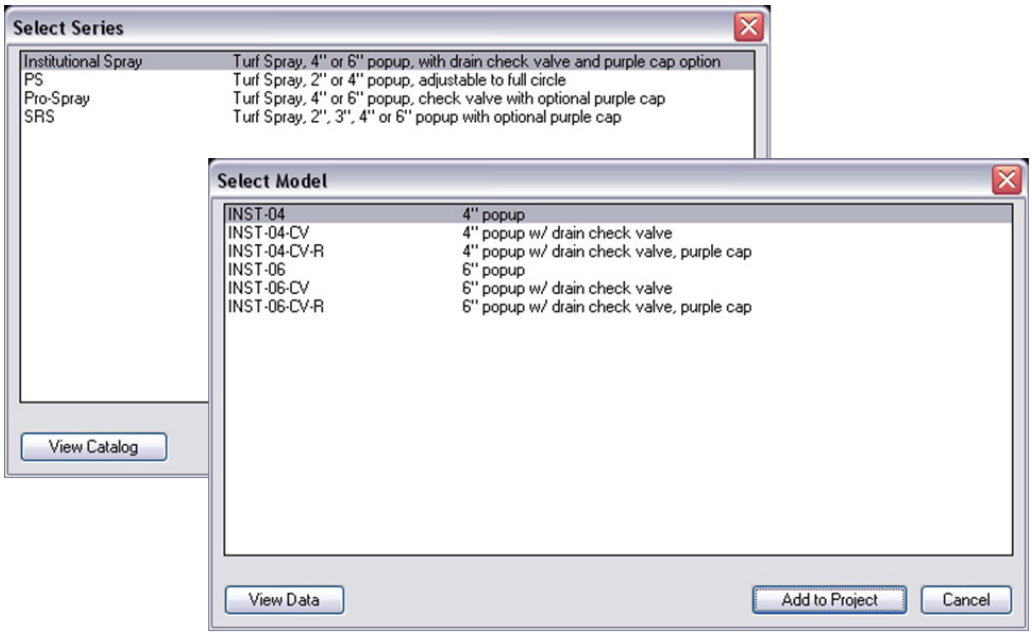
The four basic categories – Heads, Valves, Auxiliary Equipment, and Drip – with the various associated types of equipment.

If I want to use a turf spray head on a project, I first see a list of manufacturers that have this type of head.



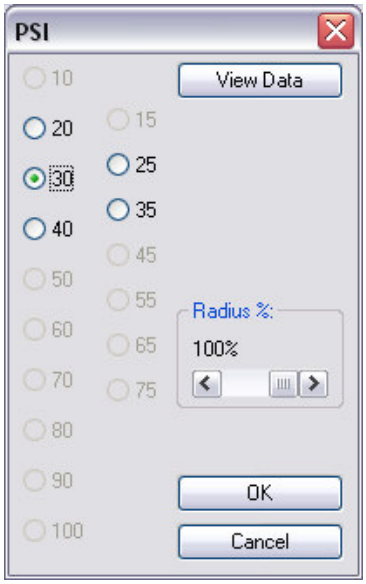
Selecting a Turf Spray head.

I just pick which manufacturer I want, and then decide which model I want that is offered by that manufacturer. I am able to view the page from the manufacturer's catalog for any piece of equipment, and am able to make a decision based up the model options I wish to use, leaving the software to determine the exact model number for me.



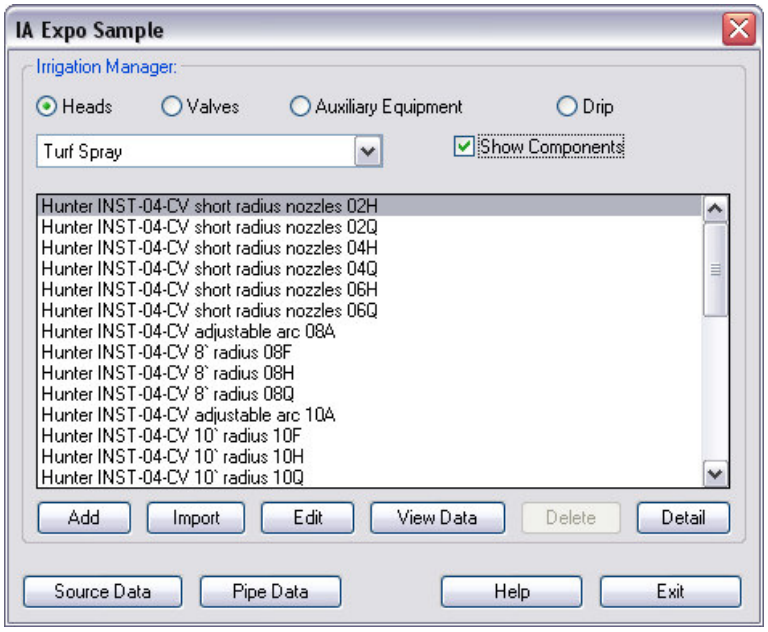
Selecting a Series and Model of Turf Spray head.

After selecting a model I will need to decide which Design Pressure I want the head to perform at, and a good program will allow you to select from any of the design pressures and performance options that the manufacturer lists for that head type. Again, I can view the performance chart from the manufacturer's catalog with one click, to see how the Design Pressure will affect the gallonage and radius of the selected head.



Selecting a Design Pressure for the Turf Spray head chosen.

As I add a spray head, again I am just picking out the model options, and the design pressure – note that the software has assembled all the fixed-arc nozzles for me, as well as the variable-arcs, the strip sprays, the low-flow nozzles, and the specialty nozzles. All of these have unique symbols assigned to them, and their correct gallonage associated with them.

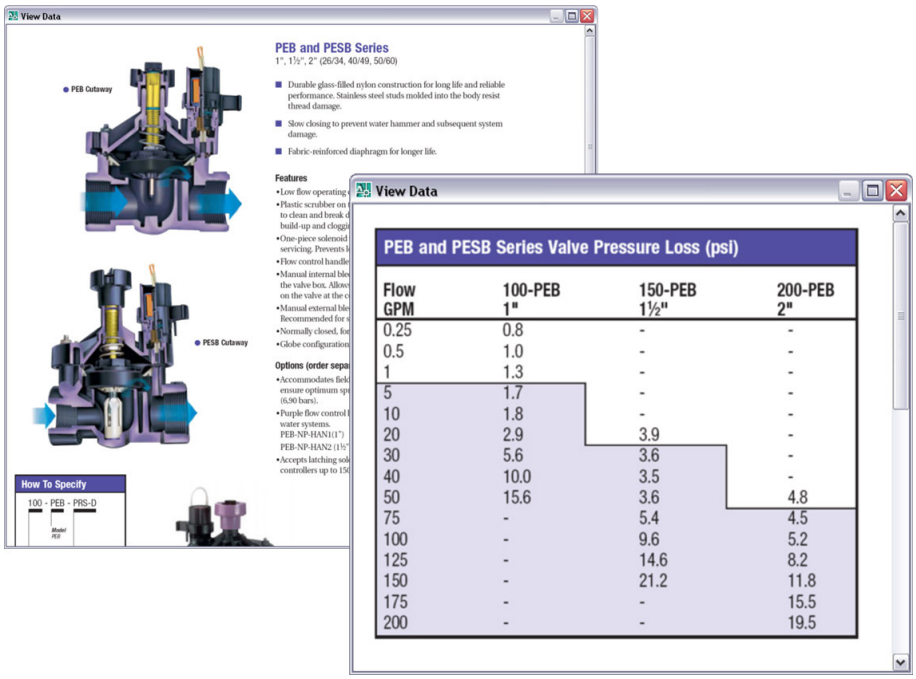


The selected Turf Spray has been added to my project, with all available nozzles assigned symbols and ready to be placed.

So already, if I was in a situation where I had to use a head I had never used before, such as a short-radius strip spray, coupled to a valve the client wants to use, the fact that I don't have the manufacturer's catalog, or any experience with the equipment is irrelevant. The software is action as an information channel, much like the internet, making it easy for me as a designer to access and utilize product information I am unfamiliar with.

Viewing the manufacturer's catalog pages for various equipment.

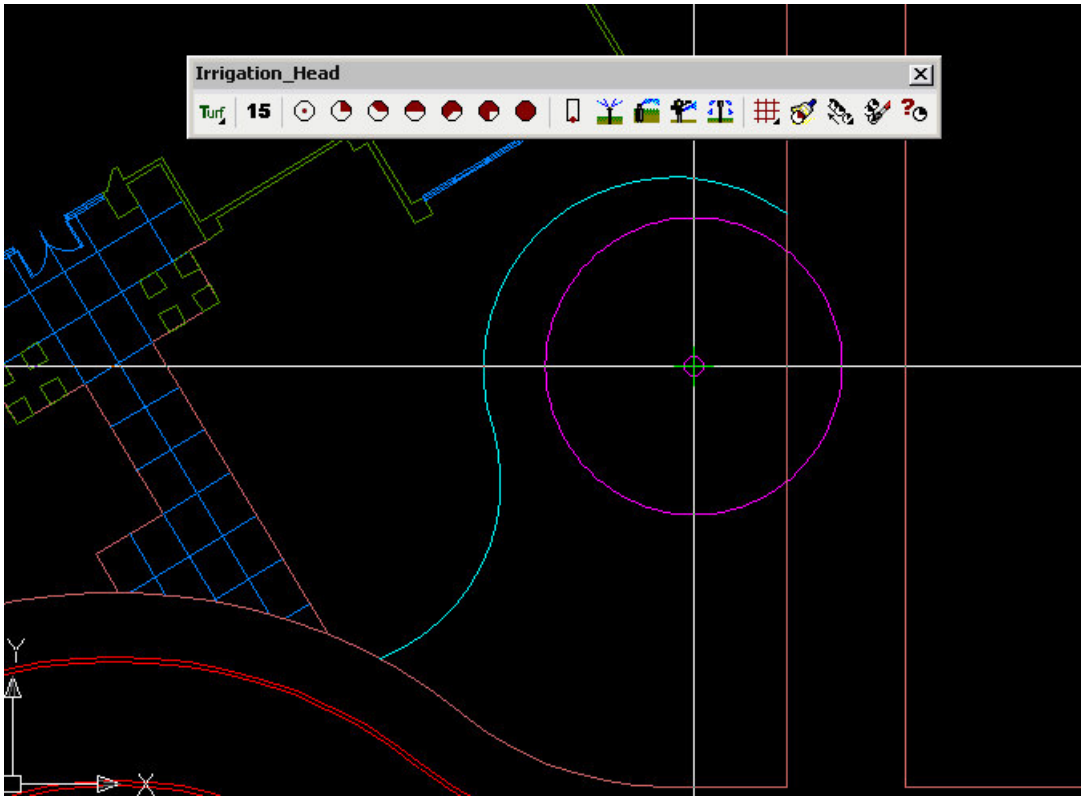
In selecting other equipment, such as valves, again I can view catalog pages instantly, see performance curves, and make my selection without having to figure out the model number myself.



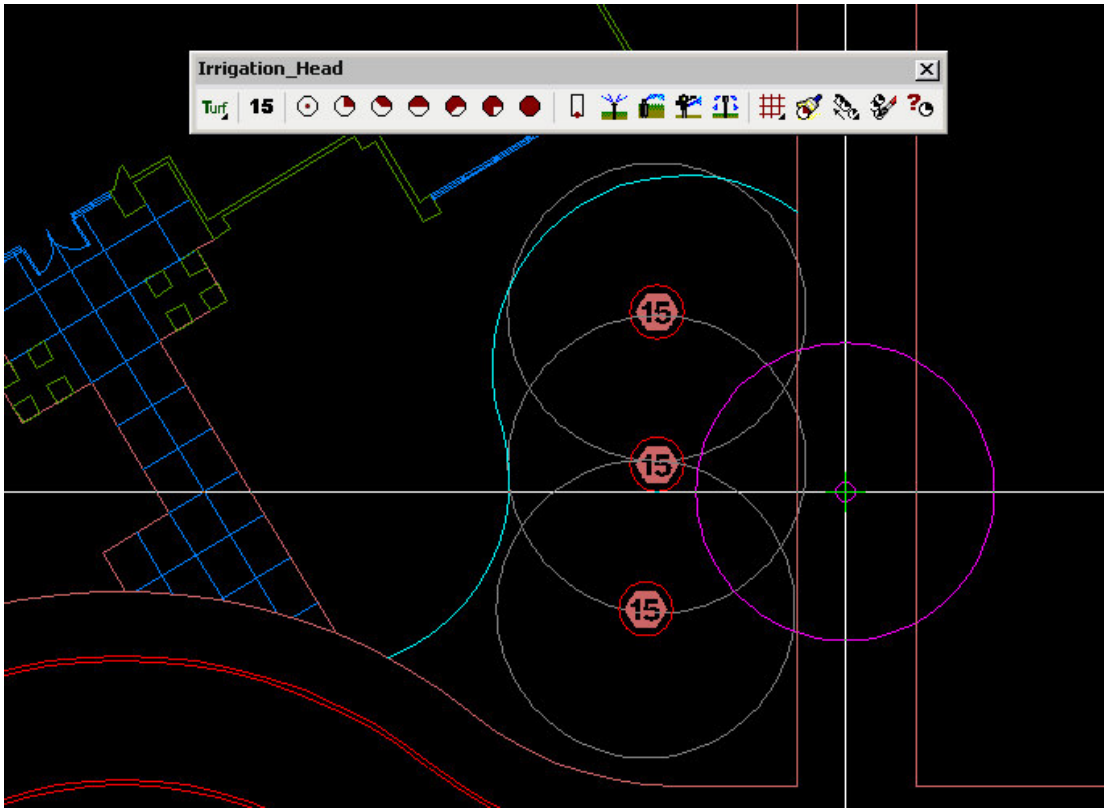
Viewing catalog pages for a valve.

Head Placement

When placing heads, it is easy for me to place from a palette of up to six different spray types, and any number or rotors, rotators such as the MP Rotator, bubblers, impacts, etc., with the system automatically placing the correct symbol, and scaled automatically for me no matter what scale I will be plotting the drawing at. Keyboard commands let me toggle among the various radiuses and nozzles. In this way, the traditional method of using a circle template to design a system is mimicked by the system, yet is much faster.

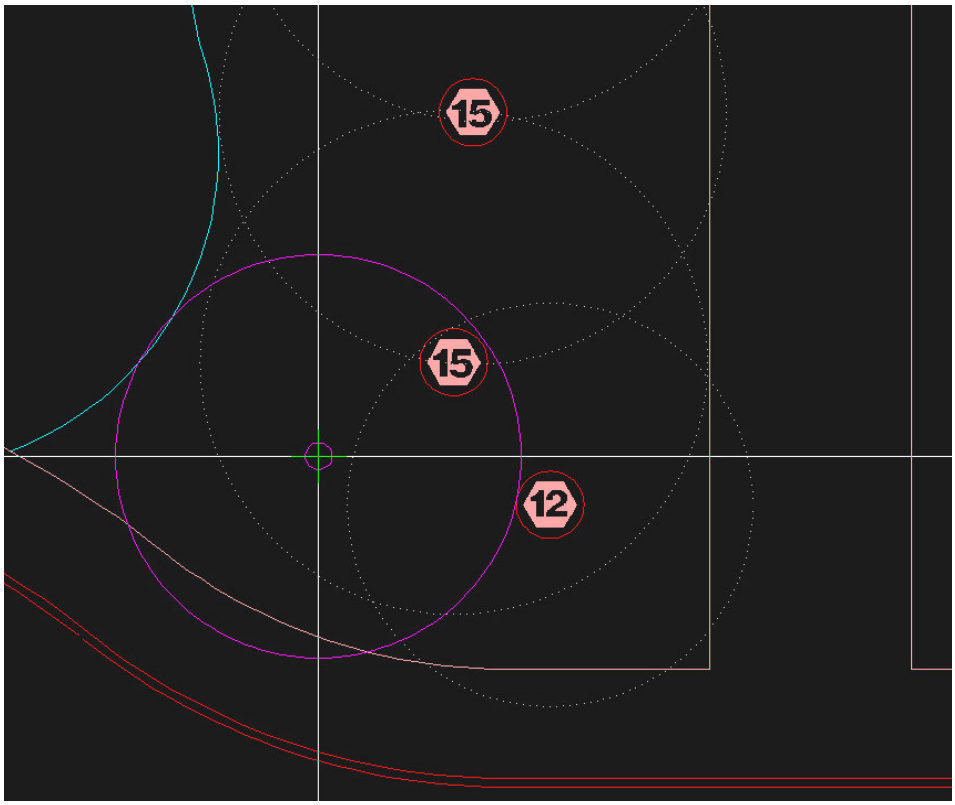


Radius preview as I place my 15' Turf Spray head.



Spray symbols are automatically sized for the scale the drawing will be plotted at.

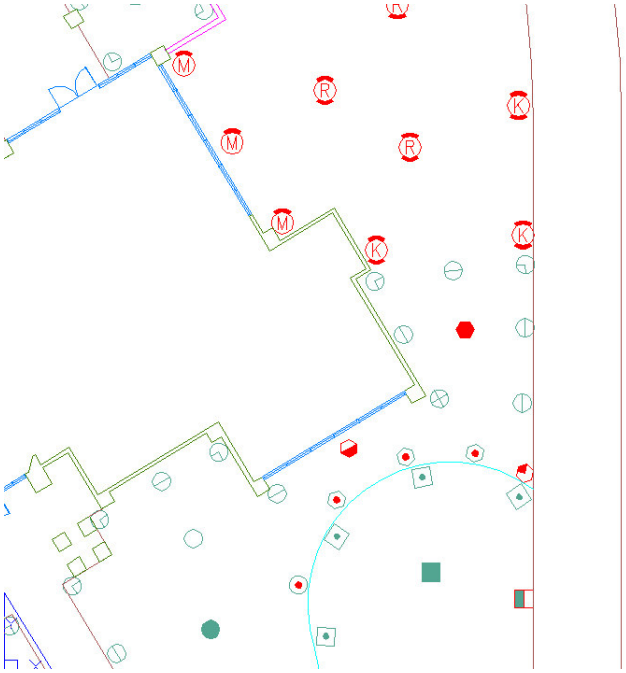
Using keyboard commands, I instantly toggle to a 12' radius preview.



I also have keyboard commands to decrease the radius, as if adjusting the radius screw on the nozzle.

GPM Total and Zoning

Now that I have placed the heads for my design, it is time to get into the GPM calculations, the area where the software provides the most dramatic improvements in speed and accuracy. I can total the GPM in the project with a single click.



FLOW TOTALS	
Shrub Rotary:	14.7
Shrub Rotor:	33.8
Shrub Spray:	138.0
Turf Rotor:	528.0
Turf Spray:	117.8
Total:	832.3

FLOW AVAILABLE	65.0 GPM
Shrub Rotary:	1 Valves
Shrub Rotor:	1 Valves
Shrub Spray:	3 Valves
Turf Rotor:	9 Valves
Turf Spray:	2 Valves
Total:	16 Valves

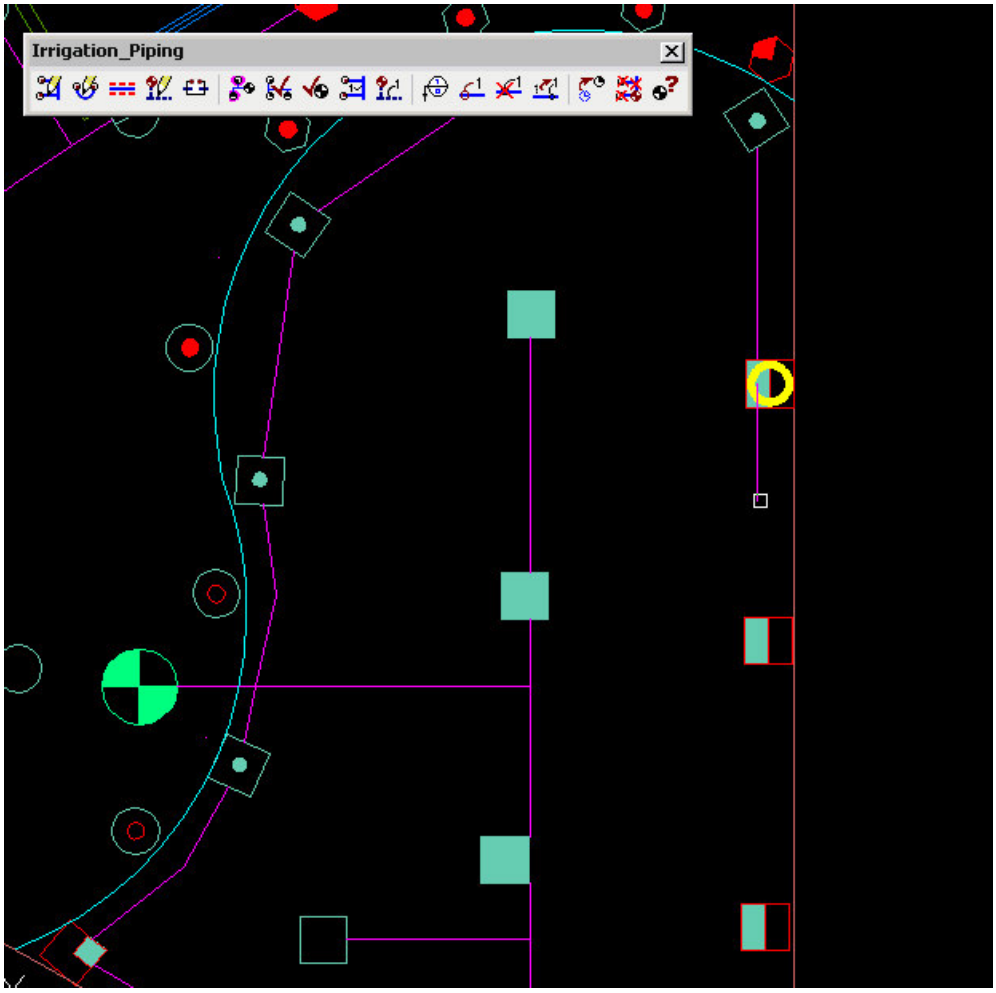
GPM Total for the entire project.

As I zone the various areas, the totals are not prone to human error, I can easily adjust the zone boundaries to be instantly recalculated, and not to mention I am even saving paper by keeping this process entirely electronic.

Zoning the various areas of the site.

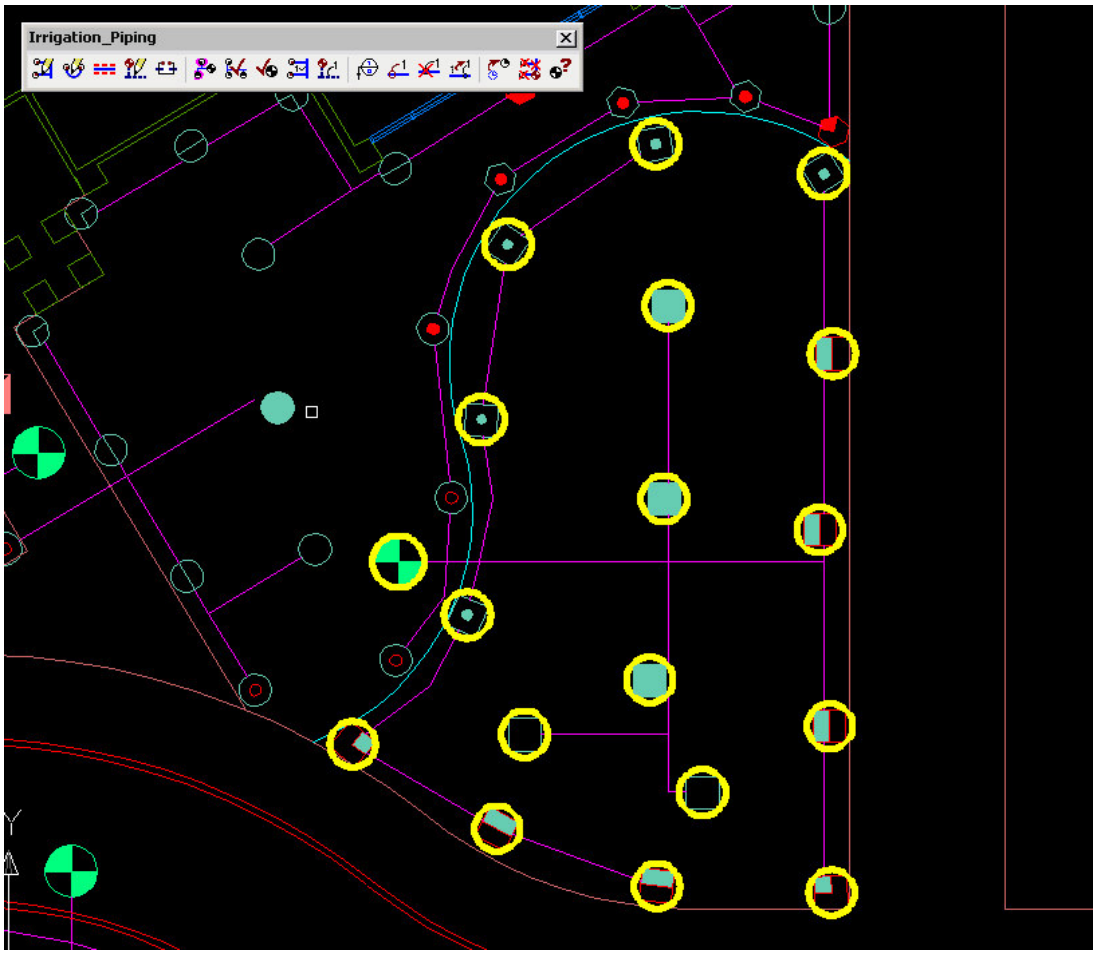
Piping and Error Checking

In order for a computer system to do my flow hydraulics and pipe sizing for me, it needs to know the order the heads are connected – this is essentially just an internalization of the pipe layout, as if we are teaching the computer the artificial intelligence of visual recognition. I draw the pipe as I would any line in the CAD system, yet the system is doing several things for me: it highlights the object I clicked on, so that I can easily see if I missed clicking on my target, and it also offsets the drawn pipe perfectly from the head symbol, for clarity of the plan.



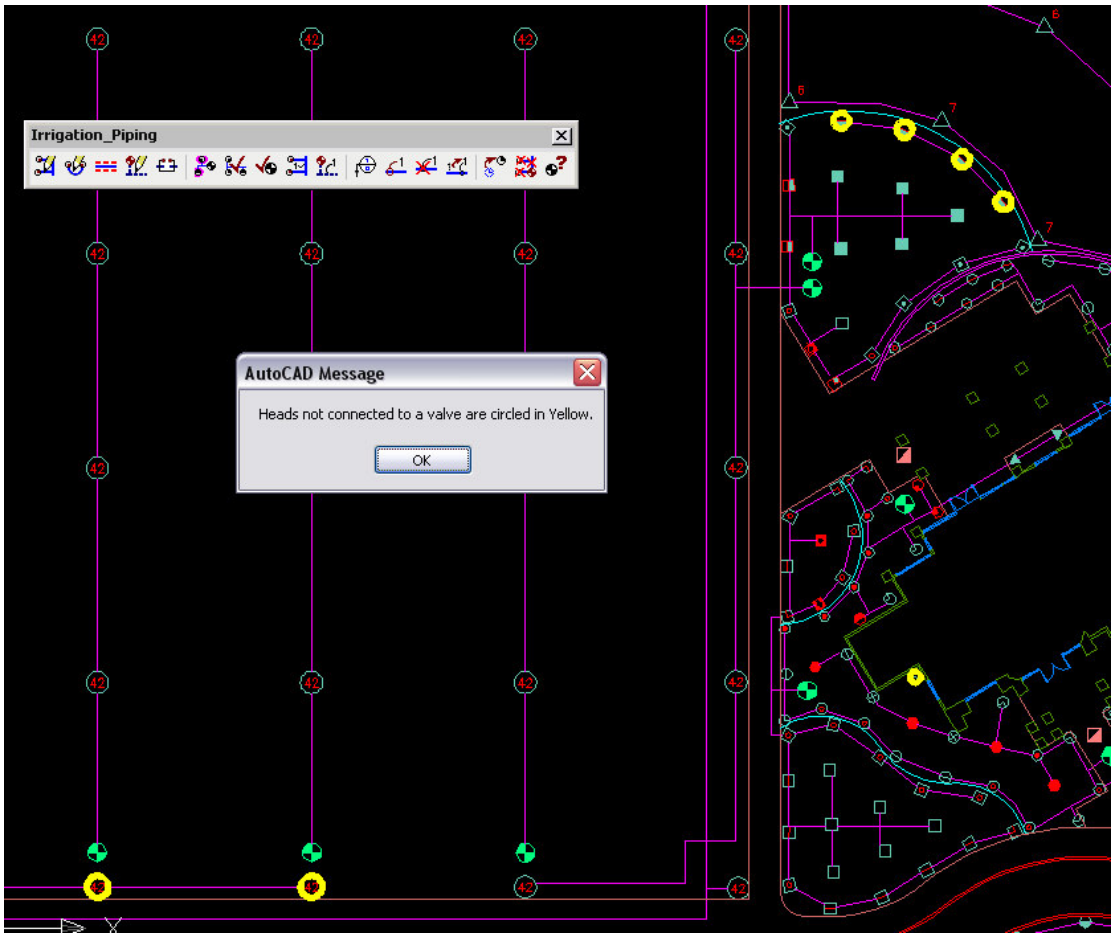
Piping to heads, the pipe is offset perfectly from the head symbols, and the Yellow highlight lets me know that I click on the head.

In using a software system, I now have abilities I could never dream of doing any other way – for instance, I can click on any head, and the system will highlight all connected items, so that I can verify that the system is correctly piped, or just to see what system a head is a part of.



Highlighting all the connected items in a system.

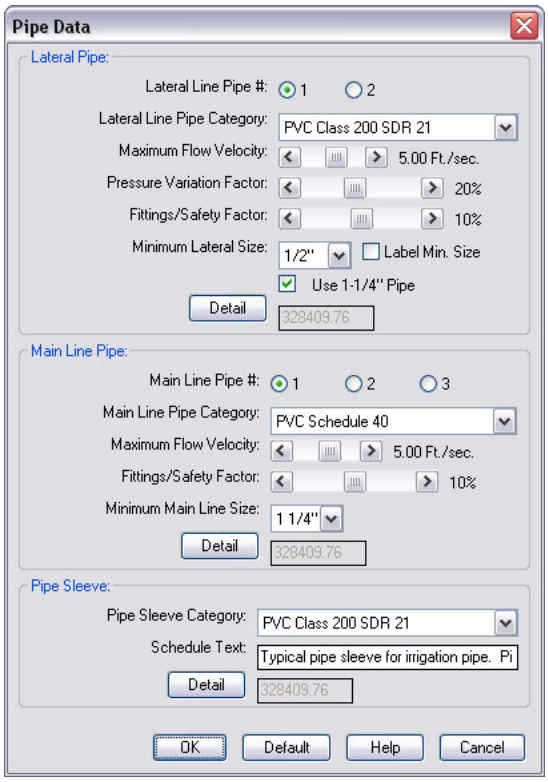
And of course I will use the ultimate in error-checking – having the system automatically highlight for me any heads that are not connected to valves. This is a classic example of replacing a lengthy manual process with something that is not only instant, but 100% accurate.



Highlighting any heads that are not connected to a valve.

Pipe Sizing

Having a computer perform the intensive calculations for automatically determining the pipe sizes is very much the holy grail of irrigation design software. My input is reduced to determining a few simple factors, such as the type of pipe I am using, the maximum velocity of the flow I would like to use, and what the Pressure Variation between the first and last head is to be.

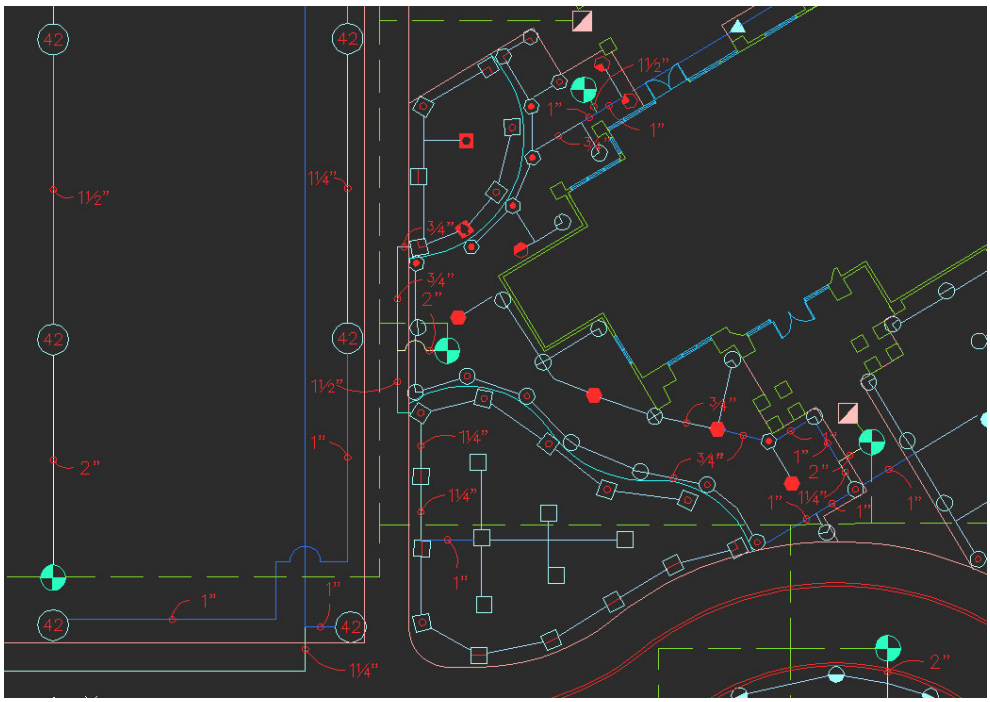


The factors used in sizing the pipe – note that for both lateral and mainline, my primary control is simply a slider to determine the maximum velocity of the water.

When you size a lateral system the software will do far more calculations than one would ever have the time or inclination to do manually. Since it knows the gallonage of each head, the desired Design Pressure, and the exact distance between heads, it can perform the actual flow hydraulics according to the Hazen-Williams equation considering the flow, the inside diameters and coefficient of the type of pipe you indicated, and the maximum water velocity selected. It also has the ability to perform this calculation over and over again as necessary, adjusting the velocity of water until the required sizes of pipe result in the system having balanced pressure (within the Pressure Variation Factor determined by the user).

In fact, the system is even able to calculate the exact precipitation rate for each station. For spray heads it uses the aggregate area of the station divided by the exact gallonage. And for rotor heads it can automatically determine if my rotors are at square or triangular spacing, and even factor in the effect of similar rotor heads from a different lateral that are spraying onto this station's areas.

Nothing will ever replace the seasoned design professional, who has viewed different types of heads in action, and can make the best determination of what kind of water to apply to different situations. Let the human do what a skilled human does, and let the computer do the intensive mathematical operations and organize the vast amount of data.

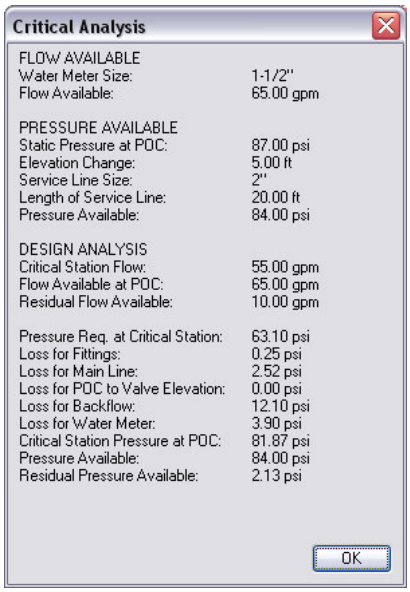


The system has sized all the appropriate pipe, and placed labels as necessary.

Sizing Mainline

As we get to sizing the mainline, again we have to leave the intelligent designer in the loop. It is up to the designer to know an appropriate maximum velocity they wish to use, or, if they are sizing for multiple valves to operate at once, to select an appropriate fixed GPM to size all pipe consistently.

The system can automatically detect how a valve will be receiving water, even automatically detecting a loop and determining the exact correct ratio to split the flow. It again will size the pipes using the Hazen-Williams formula for the type of pipe and desired velocity, but is able to adjust the velocity if necessary and resize all pipes, in a seemingly instant process. When complete, it can provide me with a Critical Analysis showing all pertinent data.

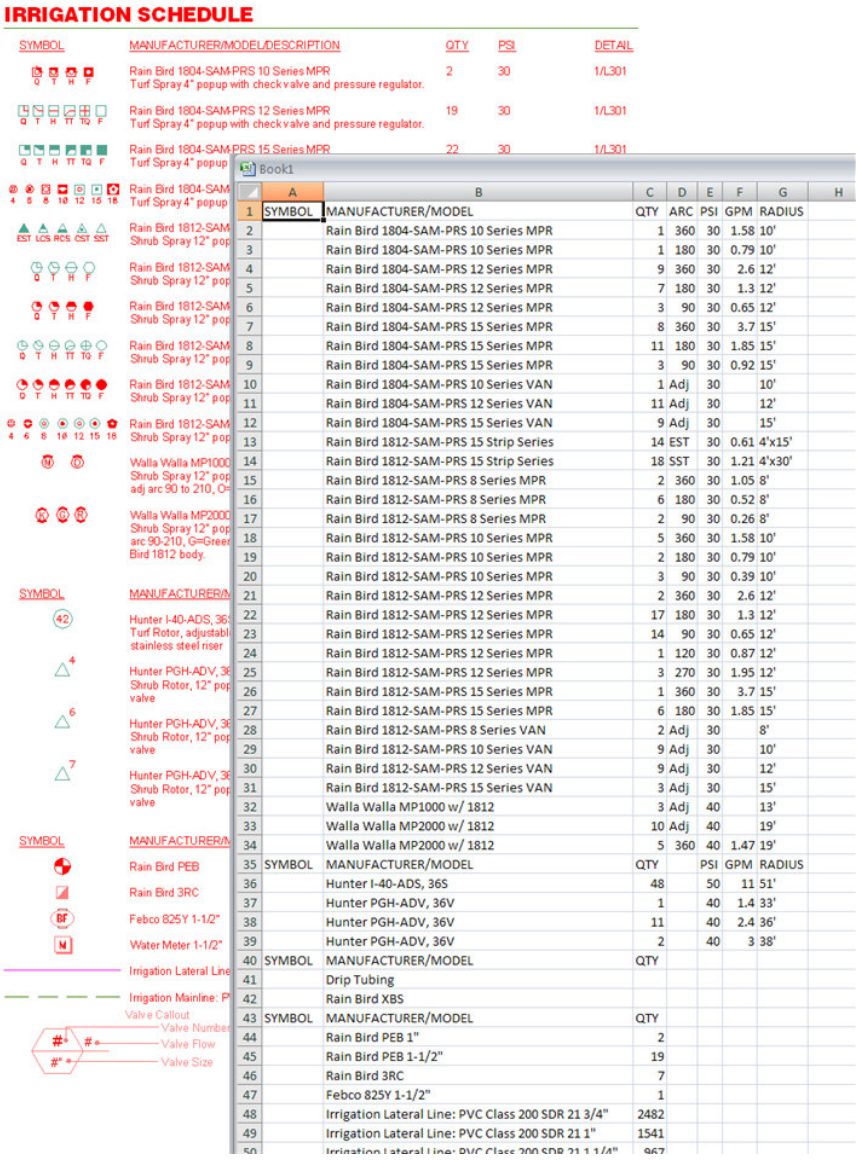


The Critical Analysis is able to show every piece of data used in sizing the Mainline.

The great thing about advanced software is that you can quickly adjust to a system that ends up being short on pressure. Suppose that after sizing your mainline, your distant rotor valves are now short 3 or 4 psi. Rather than add a booster pump, simply slow your water down and decrease your Pressure Variation. Slow your velocity on lateral lines from 5 ft/sec. to 3.75 ft/sec., and change your Pressure Variation from 20% to 10%. Both of those will result in larger pipe sizes, but that also means less pressure loss. Thus a complete resizing of several systems, and resizing the mainline, updating dozens if not hundreds of labels, is done by clicking a couple buttons in mere seconds.

Creating a Legend

When I generate a legend or schedule with a software system, I have the benefit of exact quantities, for whatever equipment was actually used in the project. I am able to instantly adjust to any variety of equipment, even if I have never used it in a project before. My lineal feet quantity of pipe is even far more accurate than any other possible method, as it is totaling the length between each insertion point of connected item. Again, my accuracy at this point is near perfect, and the time comparison is from a couple hours traditionally, to instantly by using an advanced software system.



IRRIGATION SCHEDULE

SYMBOL	MANUFACTURER/MODEL/DESCRIPTION	QTY	PSI	DETAIL
Q T H F	Rain Bird 1804-SAM-PRS 10 Series MPR Turf Spray 4" popup with check valve and pressure regulator.	2	30	1/L301
Q T H TT TQ F	Rain Bird 1804-SAM-PRS 12 Series MPR Turf Spray 4" popup with check valve and pressure regulator.	19	30	1/L301
Q T H TT TQ F	Rain Bird 1804-SAM-PRS 15 Series MPR Turf Spray 4" popup	22	30	1/L301
4 6 8 10 12 15 18	Rain Bird 1804-SAM Turf Spray 4" popup			
EST LCS RCS CST SST	Rain Bird 1812-SAM Shrub Spray 12" pop			
Q T H F	Rain Bird 1812-SAM Shrub Spray 12" pop			
Q T H F	Rain Bird 1812-SAM Shrub Spray 12" pop			
Q T H TT TQ F	Rain Bird 1812-SAM Shrub Spray 12" pop			
Q T H TT TQ F	Rain Bird 1812-SAM Shrub Spray 12" pop			
4 6 8 10 12 15 18	Rain Bird 1812-SAM Shrub Spray 12" pop			
M	Walla Walla MP1000 Shrub Spray 12" pop adj arc 90 to 210, O=			
M	Walla Walla MP2000 Shrub Spray 12" pop arc 90-210, G=Green Bird 1812 body.			

SYMBOL	MANUFACTURER/M
42	Hunter I-40-ADS, 36 Turf Rotor, adjustabl stainless steel riser
4	Hunter PGH-ADV, 36 Shrub Rotor, 12" pop valve
6	Hunter PGH-ADV, 36 Shrub Rotor, 12" pop valve
7	Hunter PGH-ADV, 36 Shrub Rotor, 12" pop valve

SYMBOL	MANUFACTURER/M
	Rain Bird PEB
	Rain Bird 3RC
BF	Febco 825Y 1-1/2"
M	Water Meter 1-1/2"
	Irrigation Lateral Line
	Irrigation Mainline: P
	Valve Callout
#4	Valve Number
#	Valve Flow
#"	Valve Size

Book1

	A	B	C	D	E	F	G	H
1	SYMBOL	MANUFACTURER/MODEL	QTY	ARC	PSI	GPM	RADIUS	
2		Rain Bird 1804-SAM-PRS 10 Series MPR	1	360	30	1.58	10'	
3		Rain Bird 1804-SAM-PRS 10 Series MPR	1	180	30	0.79	10'	
4		Rain Bird 1804-SAM-PRS 12 Series MPR	9	360	30	2.6	12'	
5		Rain Bird 1804-SAM-PRS 12 Series MPR	7	180	30	1.3	12'	
6		Rain Bird 1804-SAM-PRS 12 Series MPR	3	90	30	0.65	12'	
7		Rain Bird 1804-SAM-PRS 15 Series MPR	8	360	30	3.7	15'	
8		Rain Bird 1804-SAM-PRS 15 Series MPR	11	180	30	1.85	15'	
9		Rain Bird 1804-SAM-PRS 15 Series MPR	3	90	30	0.92	15'	
10		Rain Bird 1804-SAM-PRS 10 Series VAN	1	Adj	30		10'	
11		Rain Bird 1804-SAM-PRS 12 Series VAN	11	Adj	30		12'	
12		Rain Bird 1804-SAM-PRS 15 Series VAN	9	Adj	30		15'	
13		Rain Bird 1812-SAM-PRS 15 Strip Series	14	EST	30	0.61	4'x15'	
14		Rain Bird 1812-SAM-PRS 15 Strip Series	18	SST	30	1.21	4'x30'	
15		Rain Bird 1812-SAM-PRS 8 Series MPR	2	360	30	1.05	8'	
16		Rain Bird 1812-SAM-PRS 8 Series MPR	6	180	30	0.52	8'	
17		Rain Bird 1812-SAM-PRS 8 Series MPR	2	90	30	0.26	8'	
18		Rain Bird 1812-SAM-PRS 10 Series MPR	5	360	30	1.58	10'	
19		Rain Bird 1812-SAM-PRS 10 Series MPR	2	180	30	0.79	10'	
20		Rain Bird 1812-SAM-PRS 10 Series MPR	3	90	30	0.39	10'	
21		Rain Bird 1812-SAM-PRS 12 Series MPR	2	360	30	2.6	12'	
22		Rain Bird 1812-SAM-PRS 12 Series MPR	17	180	30	1.3	12'	
23		Rain Bird 1812-SAM-PRS 12 Series MPR	14	90	30	0.65	12'	
24		Rain Bird 1812-SAM-PRS 12 Series MPR	1	120	30	0.87	12'	
25		Rain Bird 1812-SAM-PRS 12 Series MPR	3	270	30	1.95	12'	
26		Rain Bird 1812-SAM-PRS 15 Series MPR	1	360	30	3.7	15'	
27		Rain Bird 1812-SAM-PRS 15 Series MPR	6	180	30	1.85	15'	
28		Rain Bird 1812-SAM-PRS 8 Series VAN	2	Adj	30		8'	
29		Rain Bird 1812-SAM-PRS 10 Series VAN	9	Adj	30		10'	
30		Rain Bird 1812-SAM-PRS 12 Series VAN	9	Adj	30		12'	
31		Rain Bird 1812-SAM-PRS 15 Series VAN	3	Adj	30		15'	
32		Walla Walla MP1000 w/ 1812	3	Adj	40		13'	
33		Walla Walla MP2000 w/ 1812	10	Adj	40		19'	
34		Walla Walla MP2000 w/ 1812	5	360	40	1.47	19'	
35	SYMBOL	MANUFACTURER/MODEL	QTY		PSI	GPM	RADIUS	
36		Hunter I-40-ADS, 36S	48		50	11	51'	
37		Hunter PGH-ADV, 36V	1		40	1.4	33'	
38		Hunter PGH-ADV, 36V	11		40	2.4	36'	
39		Hunter PGH-ADV, 36V	2		40	3	38'	
40	SYMBOL	MANUFACTURER/MODEL	QTY					
41		Drip Tubing						
42		Rain Bird XBS						
43	SYMBOL	MANUFACTURER/MODEL	QTY					
44		Rain Bird PEB 1"	2					
45		Rain Bird PEB 1-1/2"	19					
46		Rain Bird 3RC	7					
47		Febco 825Y 1-1/2"	1					
48		Irrigation Lateral Line: PVC Class 200 SDR 21 3/4"	2482					
49		Irrigation Lateral Line: PVC Class 200 SDR 21 1"	1541					
50		Irrigation Lateral Line: PVC Class 200 SDR 21 1 1/4"	967					

Irrigation Schedule, placed into the drawing with symbols, or sent to a spreadsheet for cost takeoff purposes.

Making Changes

The last portion of a project that a software system can assist with is in making changes. I have tools at my disposal to easily move heads along with any connected pipe, or to delete all the pipe for a system, or to replace symbols or equipment. And of course after making any number of changes, no matter how complicated, resizing my pipes and regenerating my schedules is instantaneous.

Conclusion

Other software tools that we use daily have the convenience of things such as Find and Replace, and Spellcheck – now advancements made with standardization of CAD software, and advanced database technologies have allowed the creation of highly specialized software tools for irrigation design.

Incorporating advanced technology such as this will allow us to not only be more accurate, efficient, and allow more flexibility, but will make our profession more productive and profitable.

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