City of Bozeman Pressure Calculator Guide

This calculator determines whether an irrigation system will function by calculating if the pressure available can meet the pressure required for the operation of the critical station, or the station that faces the most pressure loss. If the irrigation system cannot operate due to pressure loss, a booster pump may be needed. This calculator only works with systems using plastic pipe and accounts for the largest and most common sources of pressure loss.

The designer is responsible for several inputs, such as determining pressure at the point of connection or PSI loss at the water meter. The designer must also identify the critical station, which is usually the furthest or highest station relative to the point of connection. The calculator can then determine the pressure available, pressure required at the critical station, and residual pressure available.

This calculator does not account for factors such as site conditions differing from the designed conditions, component substitutions, or improper installation that may cause for improper operation of an irrigation system. As a result, running this calculator does not guarantee the function of an irrigation system. Instead, it is only a tool to assist in irrigation design.

There are two main components to this calculator:

1. Pressure Available at Critical Station, and
2. Pressure Required at Critical Station

This guide will discuss the inputs and outputs of these two components in detail.

Pressure Available at Critical Station

This part of the calculator determines the pressure available at the beginning of the critical station. There are several inputs that the designer will need to enter.

Input

Pressure Available at POC

This is the static water pressure in pounds per square inch (PSI) at the start of the irrigation mainline, or point of connection (POC). Depending on where the reading is taken, pipe flow loss from the service line to the POC may need to be calculated to get an accurate estimate of the Pressure Available at the POC.

Water Meter PSI Loss

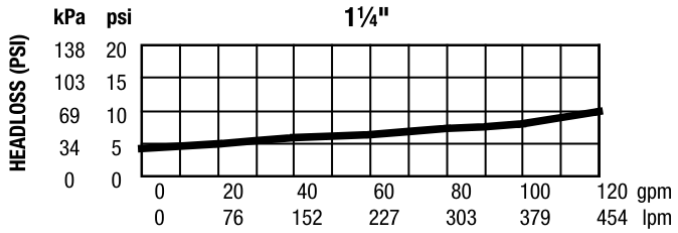
Water meters may contribute to PSI loss depending on the size of the meter and the irrigation flow in gallons per minute (GPM). This value is determined by using charts such as the one below:

PRESSURE LOSS THROUGH WATER METERS - PSI

FLOW GPM	NOMINAL SIZE						
	5/8"	3/4"	1"	1-1/2"	2"	3"	4"
1	0.2	0.1					
2	0.3	0.2					
3	0.4	0.3					
4	0.6	0.5	0.1				
5	0.9	0.6	0.2				
6	1.3	0.7	0.3				
7	1.8	0.8	0.4				
8	2.3	1.0	0.5				

Backflow Preventor PSI Loss

Backflow preventors may contribute to PSI loss depending on the size of the backflow preventor and the irrigation flow. The PSI loss can be determined from the back flow manufacturer's charts such as the one below:



Master Valve PSI Loss

A master valve is an electronically controlled isolation valve at or near the point of connection that controls the water supply to the irrigation system. A master valve may contribute to PSI loss depending on the irrigation flow and valve size. Master valve PSI loss can be determined from the valve manufacturer's chart such as the one below:

	Valve Pressure Loss (psi)		
Flow GPM	1"	1½"	2"
0.25	0.8	-	-
0.5	1.0	-	-
1	1.3	-	-
5	1.7	-	-
10	1.8	-	-
20	2.9	3.9	-
30	5.6	3.6	-
40	10.0	3.5	-
50	15.6	3.6	4.8

Flow Sensor PSI Loss

A flow sensor detects the flow of water through an irrigation system. A flow sensor may contribute to PSI loss depending on the flow and sensor size. Flow sensor PSI loss can be determined from the flow sensor manufacturer's information such as the chart below:

	UFS SERIES PRESSURE LOSS: GALLONS PER MINUTE												
PART NUMBER	0.25	0.5	1	5	10	15	20	30	40	50	60	75	100
UFS100	0	0	0	0.06	0.25	0.56	0.99	2.23	3.96	6.18			
UFS150		0	0	0.01	0.04	0.09	0.15	0.34	0.61	0.95	1.37	2.14	3.8

Elevation at POC (Feet)

This is the elevation in feet at the point of connection and is used to determine pressure change due to elevation.

Elevation at Critical Station (Feet)

This is the elevation in feet at the critical station and is used to determine pressure change due to elevation.

Mainline PSI Table

This table calculates the total mainline PSI loss from the point of connection to the critical station. Flow, Inner Diameter, and Length of the mainline segment(s) must be entered to generate mainline PSI loss. To accommodate various mainline sizes or flows, there are additional rows to enter in new values for Flow, Inner Diameter, and Length. The formula from Mainline Segment 1 and PSI Loss will need to be copied to the new row(s) to calculate PSI Loss.

Flow

Irrigation flow in gallons per minute (GPM) is entered for each mainline segment.

Inner Diameter

The mainline inner diameter in inches is entered for each mainline segment. Note that pipe sizes are nominal, so a 2" mainline may have a pipe inner diameter of 2.047.

Length

The mainline length in feet is entered for each mainline segment.

Output

PSI Change from POC to Station Due to Elevation

Pressure changes by 0.433 PSI for every foot of elevation change. This PSI change is automatically calculated from values entered in the two rows Elevation at POC (Feet) and Elevation at Critical Station (Feet). If the elevation at the POC is lower than the critical station, PSI decreases and appears as a negative number. If the elevation at the POC is higher than the critical station, PSI increases and appears as a positive number.

Mainline PSI Loss

This is the sum of all PSI Loss columns in the Mainline PSI Table.

Mainline PSI Table

PSI Loss

Irrigation mainline pressure loss is calculated by using the Hazen-Williams equation, which uses mainline inner diameter, flow, and length. When using Mainline Segment 2, 3, or 4, this equation will need to be copied over to the new row for PSI Loss to be calculated.

Fittings PSI Loss (10%)

To calculate pressure loss from mainline fittings, a 10% pressure loss based on the Mainline PSI Loss is assumed.

Pressure Available (PSI)

This is the pressure available at the critical station after accounting for pressure loss from the water meter, backflow preventor, master valve, flow sensor, elevation change, mainline, and fittings.

Pressure Required at Critical Station

This part of the calculator determines the pressure required for the critical station to function. There are several inputs that the designer will need to enter.

Input

Valve PSI Loss

A valve may contribute to PSI loss depending on the irrigation flow and valve size. Valve PSI loss can be determined from the valve manufacturer's chart such as the one below:

	Valve Pressure Loss (psi)		
Flow GPM	1"	1½"	2"
0.25	0.8	-	-
0.5	1.0	-	-
1	1.3	-	-
5	1.7	-	-
10	1.8	-	-
20	2.9	3.9	-
30	5.6	3.6	-
40	10.0	3.5	-
50	15.6	3.6	4.8

Elevation at Critical Station (Feet)

This is the elevation in feet at the critical station and is used to determine pressure change due to elevation.

Elevation at Critical Emission Device (Feet)

This is the elevation in feet at the critical emission device and is used to determine pressure change due to elevation. The critical emission device is usually the furthest or highest emission device relative to the valve.

Lateral Line PSI Table

This table calculates the total lateral line PSI loss from the valve to the critical emission device. Flow, Inner Diameter, and Length of the lateral line segment(s) must be entered to generate lateral line PSI loss. To accommodate various lateral sizes or flows, there are additional rows to enter in new values for Flow, Inner Diameter, and Length. The formula from Lateral Line Segment 1 and PSI Loss will need to be copied to the new row(s) to calculate PSI Loss.

Flow

Irrigation flow in gallons per minute (GPM) is entered for each lateral line segment.

Inner Diameter

The mainline inner diameter in inches is entered for each lateral line segment. Note that pipe sizes are nominal, so a 1" lateral line may have a pipe inner diameter of 1.029.

Length

The lateral line length in feet is entered for each lateral line segment.

Critical Emission Device Operating Pressure

This is the pressure required for the critical emission device to operate as designed. The chart below provides an example of operating pressures listed by an emission device manufacturer:

				Max Radius		
Arc	Pressure			Radius	Flow	
	PSI			ft	GPM	GPH
90°	30			8	0.17	9.6
	35			9	0.21	11.4
	40			**10**	**0.23**	**13.8**
	45			11	0.25	15.0

Output

PSI Change from Station to Critical Emission Device

Pressure changes by 0.433 PSI for every foot of elevation change. This PSI change is automatically calculated from values entered in the two rows Elevation at Critical Station (Feet) and Elevation at Critical Emission Device (Feet). If the elevation at the critical station is lower than the emission device, PSI decreases and appears as a negative number. If the elevation at the critical station is higher than the emission device, PSI increases and appears as a positive number.

Lateral Line PSI Loss

This is the sum of all PSI Loss columns in the Lateral Line PSI Table.

Lateral Line PSI Table

PSI Loss

Irrigation lateral line pressure loss is calculated by using the Hazen-Williams equation, which uses lateral line inner diameter, flow, and length. When using Lateral Line Segment 2, 3, or 4, this equation will need to be copied over to the new row for PSI Loss to be calculated.

Fittings PSI Loss (10%)

To calculate pressure loss from lateral line fittings, a 10% pressure loss based on the Lateral Line PSI Loss is assumed.

Pressure Required (PSI)

This is the pressure required for the critical station to operate as designed after accounting for pressure loss from the valve, elevation change, lateral line, and fittings.

Residual Pressure Available (PSI)

This is the pressure available in the irrigation system while the critical station is running. If this is a positive number, then the system should function as intended. If this is a negative number, a booster pump may be needed to provide additional pressure for the critical station.