Vineyard Irrigation Proficiency Series – Part 1

Vineyard Irrigation Systems

January 15, 2021

Agenda

- Irrigation Water Quality Considerations
- Importance of Pressure and Flow in Design of Drip Systems
- Types of Drip Products
- Installation/Layout of Drip Irrigation Considerations
- Advantages & Disadvantages of Sprinkler and Flood Irrigation in Vineyards

Water Quality Considerations

Is your water source suitable for irrigation?

Irrigation Water Sources

- Groundwater
  - Wells at Vineyard location
- Surface Water
  - River/Lake/Pond/Reservoir
- Utility Provided Sources
  - MUD/SUD

Groundwater

- Requires Minimal Filtration
  - Sand may be a concern
- Need accurate data on available flow (gpm) and pressure
- Huge variation in water quality exists around the State
  - All irrigation water should be <u>tested</u>!

Surface Water

Clogging of drip lines and emitters is a concern and more intense filtering is required due to:

- Biological Sources
  - Algae/Bacteria
  - injection of chlorine may be required
- Sediment-Trash

Surface Water

Do you need a permit?

- No, if all the water originates on your property which you capture in a pond
- Maybe, if you use water from a small, un-named creek that extends beyond your property
- Yes, if you use water from any other named water body (stream, lake, reservoir, river, etc.)

- Contact: Water Rights Permitting, TCEQ

https://www.tceq.texas.gov/permitting/water_rights/wr-permitting/water_rights.html

Utility Provided

- Typically treated water
  - Already contains chlorine and other disinfectants to prevent biological growth in pipelines
  - Pre-filtered – only screen filters needed with drip irrigation
- Data on available Pressure & Flow at your connection is needed for design of irrigation systems
- Most expensive source of water

Irrigation Water Quality

- The irrigation water needs to be tested to determine its suitability for use in vineyards
- A Routine Analysis from the Texas A&M Soil, Water and Forage Testing Laboratory is sufficient

1. Routine Analysis (R) (201)	**$25 per sample**
(Conductivity, pH, Na, Ca, Mg, K, CO_3^{2-}, HCO_3^-, SO_4^{2-}, Cl^-, P, B, Nitrate-N. Hardness, and SAR)	
2. R + Metals (202)	**$40 per sample**
In addition to Routine Analysis includes: (Zn, Fe, Cu, and Mn)	
3. R + Titrate of Drip Irrigation (203)	**$33 per sample**
4. R + Metals + Titrate for Drip Irrigation (204)	**$47 per sample**
5. R + Metals + Heavy metals and Fluoride (205)	**$75 per sample**
In addition to test number 2, includes As, Ba, Cr, Cd, F, Ni, Pb.	
Hardcopy mailed to address listed above	**$2 per invoice**

AgriLIFE EXTENSION
Texas A&M System

Water Analysis Report

Soil, Water and Forage Testing Laboratory
Department of Soil and Crop Sciences
2610 F&B Road, 2478 TAMU
College Station, TX 77843-2478
979-845-4816

Visit our website:
http://soiltesting.tamu.edu

Format based on publication SCS-2002-12

Report generated for:
Charles Swanson
201 Scoates Hall, 2117 TAMU
College Station, TX 77843

Laboratory #: 24754
Customer Sample ID: 1
Date Processed: 11/6/2013
Sample from Polk County
Water Source =Well

Water Use =Irrigation

Parameter analyzed		Results	Units	Method	V. Limiting	Limiting	Acceptable
Calcium (Ca)		41	ppm	ICP			*****
Magnesium (Mg)		3	ppm	ICP			*****
Sodium (Na)		390	ppm	ICP	*****		
Potassium (K)		12	ppm	ICP			*****
Boron (B)		0.42	ppm	ICP		*****	
Carbonate (CO_3)		0	ppm	Titr.			*****
Bicarbonate (HCO_3)		503	ppm	Titr.		*****	
Sulfate (SO_4=calculated from total S)	<	1	ppm	ICP			*****
Chloride (Cl-)		407	ppm	Titr.		*****	
Nitrate-N (NO_3-N)	<	0.01	ppm	Cd-red.			*****
Phosphorus (P)		0.04	ppm	ICP			*****
pH		7.20		ISE			*****
Conductivity		1758	umhos/cm	Cond.		*****	
Hardness		7	grains CaCO3/gallon	Calc.			*****
Hardness		114	ppm CaC03	Calc.			*****
Alkalinity		412	ppm CaC03	Calc.		*****	
Total Dissolved Salts (TDS)		1357	ppm	Calc.	*****		
SAR		15.8		Calc.		*****	
Iron (Fe)							
Zinc (Zn)							
Copper (Cu)							
Manganese (Mn)							
Arsenic (As)							
Barium (Ba)							
Nickel (Ni)							
Cadmium (Cd)							
Lead (Pb)							
Chromium (Cr)							
Fluoride (F)							
Charge Balance (cation/anion*100)		98		Calc.			

ppm=parts per million=milligrams per liter

N/A, not applicable for this water use

Descriptions of each water parameter, potential use issues and target levels are provided in publication SCS-2002-10, Description of Water Analysis Parameters.

ICP, inductively coupled plasma; Titr., titration; ISE, ion selective electrode; Cd-red., cadmium reduction; cond., conductivity; calc., calculated

Water Source =Well

Water Use =Irrigation

Parameter analyzed		Results	Units	Method	V. Limiting	Limiting	Acceptable
Calcium (Ca)		41	ppm	ICP			*****
Magnesium (Mg)		3	ppm	ICP			*****
Sodium (Na)		390	ppm	ICP	*****		
Potassium (K)		12	ppm	ICP			*****
Boron (B)		0.42	ppm	ICP		*****	
Carbonate (CO_3)		0	ppm	Titr.			*****
Bicarbonate (HCO_3)		503	ppm	Titr.		*****	
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Arsenic (As)							
Barium (Ba)							
Nickel (Ni)							
Cadmium (Cd)							
Lead (Pb)							
Chromium (Cr)							
Fluoride (F)							
Charge Balance (cation/anion*100)		98		Calc.			

Water Quality Concerns - Salts

- 2 Types of Salt Problems
  - Salinity
  - Sodium
- Water with high salinity is toxic to plants and poses a *salinity hazard*

Types of Salinity Problems				
salinity hazard	affects →	plants	can lead to →	saline soil condition
sodium	affects →	soils	can lead to →	sodic soil condition

Water Salinity

- Water Salinity is reported in either/both:
  - TDS – Total Dissolved Solids
  - EC – Electric Conductivity (also referred to as "conductivity")
- Both measure the same parameters using different methods
- TDS and EC can be converted from one to the other

Soil Salinity

- Salinity will build-up in the soil over time
- Soils with high levels of total salinity called *saline* soils
- When salt build-up in the soil becomes high enough, physiological drought conditions result
  - Plants wilt because they are unable to absorb the water

Evaporation of Saline Irrigation Water from Drip Irrigation of Grapes

Sodium Hazard

- Irrigation water containing large amounts of sodium affect soil properties
- The higher the clay content, the more serious the problem
- Over time, sodium will build up in the soil, resulting in hard and compact soils which become increasingly impervious to water penetration
  - Amending the soil with gypsum or sulfuric acid can increase soil solubility and infiltration

Sodium Hazard

- Sodium Hazard is typical expressed in terms of SAR
- Sodium Adsorption Ratio (SAR) is the ratio of sodium to calcium and magnesium
- Calcium and Magnesium counter the effects of sodium

Classification of Irrigation Water

Table 4. Permissible limits for classes of irrigation water.

Classes of water	Concentration, total dissolved solids	
	Electrical conductivity µmhos*	Gravimetric ppm
Class 1, Excellent	250	175
Class 2, Good	250-750	175-525
Class 3, Permissible[1]	750-2,000	525-1,400
Class 4, Doubtful[2]	2,000-3,000	1,400-2,100
Class 5, Unsuitable[2]	3,000	2,100

*Micromhos/cm at 25 degrees C.
[1]Leaching needed if used
[2]Good drainage needed and sensitive plants will have difficulty obtaining stands

Table 5. The sodium hazard of water based on SAR Values.

SAR values	Sodium hazard of water	Comments
1-10	Low	Use on sodium sensitive crops such as avocados must be cautioned.
10 - 18	Medium	Amendments (such as Gypsum) and leaching needed.
18 - 26	High	Generally unsuitable for continuous use.
> 26	Very High	Generally unsuitable for use.

Soil Salinity Tolerance of Grapes

Table 7. Soil salinity tolerance levels[1] for different crops. (continued)

Crop	Yield potential, EC_e				Maximum EC_e
	100%	90%	75%	50%	
Fruit crops					
Almond	1.5	2.0	2.8	4.1	7
Apple, Pear	1.7	2.3	3.3	4.8	8
Apricot	1.6	2.0	2.6	3.7	6
Avocado	1.3	1.8	2.5	3.7	6
Date palm	4.0	6.8	10.9	17.9	32
Fig, Olive, Pomegranate	2.7	3.8	5.5	8.4	14
Grape	1.5	2.5	4.1	6.7	12
Grapefruit	1.8	2.4	3.4	4.9	8
Lemon	1.7	2.3	3.3	4.8	8
Orange	1.7	2.3	3.2	4.8	8
Peach	1.7	2.2	2.9	4.1	7
Plum	1.5	2.1	2.9	4.3	7
Strawberry	1.0	1.3	1.8	2.5	4
Walnut	1.7	2.3	3.3	4.8	8

[1]Based on the electrical conductivity of the saturated extract taken from a root zone soil sample (EC_e) measured in mmhos/cm.

[a]During germination and seedling stage EC_e should not exceed 4 to 5 mmhos/cm except for certain semi-dwarf varieties.

[b]During germination EC_e should not exceed 3 mmhos/cm.

Other Water Quality Concerns - pH

- High pH is generally classified as Hard water
- Water with a high pH can cause corrosion of metal components of the irrigation system
- Can be managed by injecting acid during chemigation

Other Water Quality Concerns - Boron

- Boron is an essential nutrient at low concentrations
- But is toxic at higher levels
- Boron will build up over time
- Removal from irrigation water is expensive

Other Water Quality Concerns - Boron

- Grapes are very sensitive to boron
- Boron toxicity can occur at boron levels of 1 ppm in the soil

Table 10. Limits of boron in irrigation water. (Adapted from Rowe and Abdel-Magid, 1995)

A. Permissible Limits (Boron in parts per million)

Class of water	Crop group		
	Sensitive	Semitolerant	Tolerant
Excellent	<0.33	<0.67	<1.00
Good	0.33 to 0.67	0.67 to 1.33	1.00 to 2.00
Permissible	0.67 to 1.00	1.33 to 2.00	2.00 to 3.00
Doubtful	1.00 to 1.25	2.00 to 2.50	3.00 to 3.75
Unsuitable	>1.25	>2.5	>3.75

B. Crop groups of boron tolerance (in each plant group, the first names are considered as being more tolerant; the last names, more sensitive).

Sensitive (1.0 mg/L of Boron)	Semitolerant (2.0 mg/L of Boron)	Tolerant (4.0 mg/L of Boron)
Pecan	Sunflower (native)	Athel (Tamarix aphylla)
Walnut (Black, Persian, or English)	Potato	Asparagus
Jerusalem artichoke	Cotton (Acala and Pima)	Palm (Phoenix canariensis)
Navy bean	Tomato	Date palm (P. dactylifera)
American elm	Sweetpea	Sugar beet
Plum	Radish	Mangel
Pear	Field pea	Garden beet
Apple	Ragged Robin rose	Alfalfa
Grape (Sultania and Malaga)	Olive	Gladiolus
Kadota fig	Barley	Broad bean
Persimmon	Wheat	Onion
Cherry	Corn	Turnip
Peach	Milo	Cabbage
Apricot	Oat	Lettuce
Thornless blackberry	Zinnia	Carrot
Orange	Pumpkin	
Avocado	Bell pepper	
Grapefruit	Sweet potato	
Lemon	Lima bean	
(0.3 mg/L of Boron)	(1.0 mg/L of Boron)	(2.0 mg/L of Boron)

Irrigation System Design

Importance of Pressure and Flow

Hydraulics Concepts

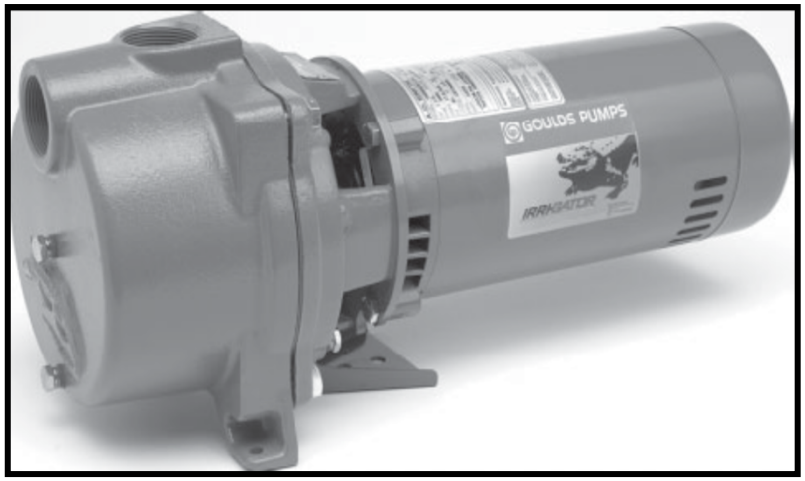
What is Hydraulics?

- Hydraulics is the science of water and other liquids in motion
- Irrigation hydraulics focuses on the relationship between flow and pressure which affects affect:
  - Sprinkler and Drip Emitter Performance
  - Irrigation system efficiency
  - Irrigation System Costs
    - Materials
    - Component Sizing

Pressure

How is pressure created?

- Weight of the Water (Gravity)
- Mechanical Means (Pump)



Types of Pressure

- Dynamic Pressure
  - Pressure at a point when water is moving
  - Also referred to as “operating pressure”
- Static Pressure
  - Pressure at a point when there is no water moving

- Note: Static Pressure is always greater than dynamic pressure

Factors Affecting Dynamic Pressure

- Changes in Elevation
  - Water traveling downhill increases pressure
  - Water traveling uphill decreases pressure
- Friction loss in various components
  - Lose pressure through pipes, fittings, valves, meters, filters and other irrigation components

Flow

Water Movement in the System

- **<u>Flow</u>**: the volume of water per unit of time
  - Gallons Per Minute (GPM)
  - Gallons Per Hour (GPH)

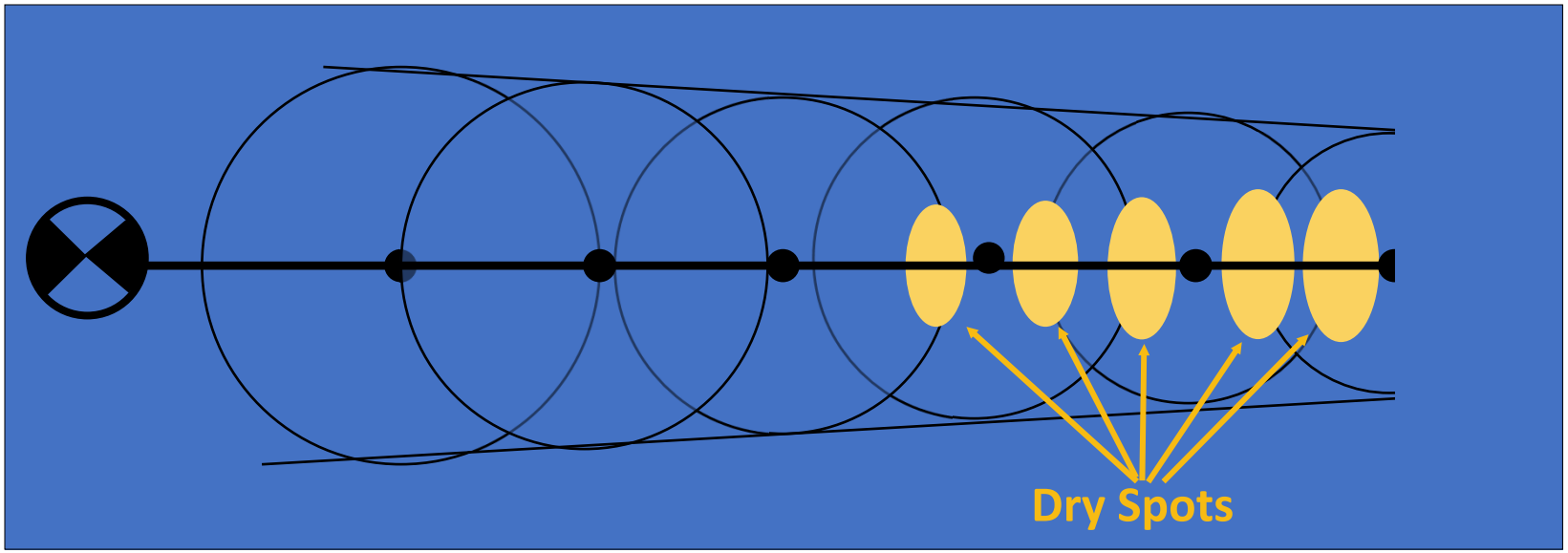
- **<u>Velocity</u>**: speed of moving water
  Measured in:
  - Feed Per Second (fps)

Water Movement in the System

- Friction loss refers to the loss of pressure as water flows through pipelines and other components of the irrigation system
- Proper irrigation system design ensures that there is enough pressure at the emitter or nozzle for it to operate properly

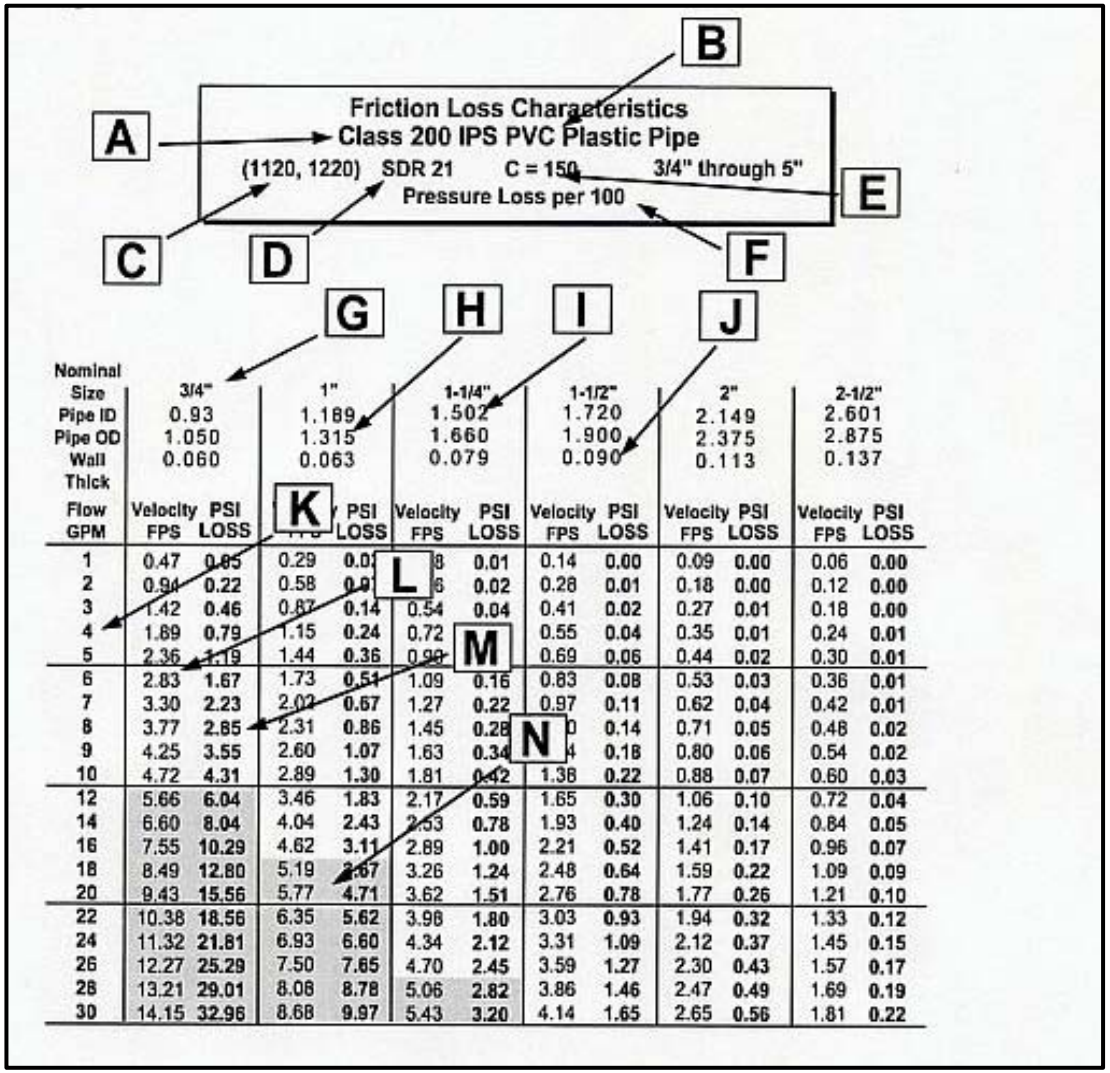
Inadequate Pressure Example

Uneven water distribution and dry spots on the end



Reading a Friction Loss Table

- A, B = Type of pipe
- F = Pressure loss/ 100 ft. of pipe
- G = Nominal size of pipe
- H – J = Actual sizes of pipe
- K = Flow quantities, gpm
- L = Velocity in fps
- M = PSI loss/ 100 ft. of pipe



Friction Loss Characteristics
Class 200 IPS PVC Plastic Pipe
(1120, 1220) SDR 21 C = 150 3/4" through 5"
Pressure Loss per 100

Nominal Size	3/4"		1"		1-1/4"		1-1/2"		2"		2-1/2"	
Pipe ID	0.93		1.189		1.502		1.720		2.149		2.601	
Pipe OD	1.050		1.315		1.660		1.900		2.375		2.875	
Wall Thick	0.060		0.063		0.079		0.090		0.113		0.137	
Flow GPM	Velocity FPS	PSI LOSS	Velocity FPS	PSI LOSS	Velocity FPS	PSI LOSS	Velocity FPS	PSI LOSS	Velocity FPS	PSI LOSS	Velocity FPS	PSI LOSS
1	0.47	0.85	0.29	0.0[illegible]	[illegible]	0.01	0.14	0.00	0.09	0.00	0.06	0.00
2	0.94	0.22	0.58	0.0[illegible]	[illegible]	0.02	0.28	0.01	0.18	0.00	0.12	0.00
3	1.42	0.46	0.87	0.14	0.54	0.04	0.41	0.02	0.27	0.01	0.18	0.00
4	1.89	0.79	1.15	0.24	0.72	[illegible]	0.55	0.04	0.35	0.01	0.24	0.01
5	2.36	1.19	1.44	0.36	[illegible]	[illegible]	0.69	0.06	0.44	0.02	0.30	0.01
6	2.83	1.67	1.73	0.51	1.09	0.16	0.83	0.08	0.53	0.03	0.36	0.01
7	3.30	2.23	2.02	0.67	1.27	0.22	0.97	0.11	0.62	0.04	0.42	0.01
8	3.77	2.85	2.31	0.86	1.45	0.28	[illegible]	0.14	0.71	0.05	0.48	0.02
9	4.25	3.55	2.60	1.07	1.63	0.34	[illegible]	0.18	0.80	0.06	0.54	0.02
10	4.72	4.31	2.89	1.30	1.81	0.42	1.38	0.22	0.88	0.07	0.60	0.03
12	5.66	6.04	3.46	1.83	2.17	0.59	1.65	0.30	1.06	0.10	0.72	0.04
14	6.60	8.04	4.04	2.43	2.53	0.78	1.93	0.40	1.24	0.14	0.84	0.05
16	7.55	10.29	4.62	3.11	2.89	1.00	2.21	0.52	1.41	0.17	0.96	0.07
18	8.49	12.80	5.19	3.87	3.26	1.24	2.48	0.64	1.59	0.22	1.09	0.09
20	9.43	15.56	5.77	4.71	3.62	1.51	2.76	0.78	1.77	0.26	1.21	0.10
22	10.38	18.56	6.35	5.62	3.98	1.80	3.03	0.93	1.94	0.32	1.33	0.12
24	11.32	21.81	6.93	6.60	4.34	2.12	3.31	1.09	2.12	0.37	1.45	0.15
26	12.27	25.29	7.50	7.65	4.70	2.45	3.59	1.27	2.30	0.43	1.57	0.17
28	13.21	29.01	8.08	8.78	5.06	2.82	3.86	1.46	2.47	0.49	1.69	0.19
30	14.15	32.96	8.68	9.97	5.43	3.20	4.14	1.65	2.65	0.56	1.81	0.22

Example: Friction Loss Calculation Using the Table for a Class 200 PVC pipeline

Find the friction loss in:

- 100 ft. length of Class 200 PVC pipe
- Flow is 6 gpm
- Nominal pipe size is ¾ in. diameter

Example: Solution

- Use Class 200 PVC table
- Length of pipe is 100 ft.

Step 1: Find 6 gpm in first column

Step 2: Find ¾ in. pipe diameter column

Step 3: Read 1.67 psi loss per 100 ft. of pipe

Friction Loss Characteristics
Class 200 IPS PVC Plastic Pipe
(1120, 1220) SDR 21 C = 150 3/4" through 5"
Pressure Loss per 100

Step 2

Nominal Size	3/4"		1"		1-1/4"		1-1/2"		2"		2-1/2"	
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Pipe OD	1.050		1.315		1.660		1.900		2.375		2.875	
Wall Thick	0.060		0.063		0.079		0.090		0.113		0.137	
Flow GPM	Velocity FPS	PSI LOSS	Velocity FPS	PSI LOSS	Velocity FPS	PSI LOSS	Velocity FPS	PSI LOSS	Velocity FPS	PSI LOSS	Velocity FPS	PSI LOSS
1	0.47	**0.05**	0.29	**0.02**	[illegible]	[illegible]	0.14	**0.00**	0.09	**0.00**	0.06	**0.00**
2	0.94	**0.22**	0.58	**0.07**	[illegible]	[illegible]	0.28	**0.01**	0.18	**0.00**	0.12	**0.00**
3	1.42	**0.46**	0.87	**0.14**	[illegible]	[illegible]	0.41	**0.02**	0.27	**0.01**	0.18	**0.00**
4	1.89	**0.79**	1.15	**0.24**	0.72	**0.08**	0.55	**0.04**	0.35	**0.01**	0.24	**0.01**
5	2.36	**1.19**	1.44	**0.36**	0.90	**0.12**	0.69	**0.06**	0.44	**0.02**	0.30	**0.01**
6	2.83	**1.67**	1.73	**0.51**	1.09	**0.16**	0.83	**0.08**	0.53	**0.03**	0.36	**0.01**
7	3.30	**2.23**	2.02	**0.67**	1.27	**0.22**	0.97	**0.11**	0.62	**0.04**	0.42	**0.01**
8	3.77	**2.85**	2.31	**0.86**	1.45	**0.28**	0.00	**0.14**	0.71	**0.05**	0.48	**0.02**
9	4.25	**3.55**	2.60	**1.07**	1.63	**0.34**	0.04	**0.18**	0.80	**0.06**	0.54	**0.02**
10	4.72	**4.31**	[illegible]	[illegible]	[illegible]	**0.42**	1.38	**0.22**	0.88	**0.07**	0.60	**0.03**
12	5.66	**6.04**	[illegible]	[illegible]	[illegible]	**0.59**	1.65	**0.30**	1.06	**0.10**	0.72	**0.04**
14	6.60	**8.04**	4.04	**2.43**	2.53	**0.78**	1.93	**0.40**	1.24	**0.14**	0.84	**0.05**
16	7.55	**10.29**	4.62	**3.11**	2.89	**1.00**	2.21	**0.52**	1.41	**0.17**	0.96	**0.07**
18	8.49	**12.80**	5.19	**3.67**	3.26	**1.24**	2.48	**0.64**	1.59	**0.22**	1.09	**0.09**
20	9.43	**15.56**	5.77	**4.71**	3.62	**1.51**	2.76	**0.78**	1.77	**0.26**	1.21	**0.10**
22	10.38	**18.56**	6.35	**5.62**	3.98	**1.80**	3.03	**0.93**	1.94	**0.32**	1.33	**0.12**
24	11.32	**21.81**	6.93	**6.60**	4.34	**2.12**	3.31	**1.09**	2.12	**0.37**	1.45	**0.15**
26	12.27	**25.29**	7.50	**7.65**	4.70	**2.45**	3.59	**1.27**	2.30	**0.43**	1.57	**0.17**
28	13.21	**29.01**	8.08	**8.78**	5.06	**2.82**	3.86	**1.46**	2.47	**0.49**	1.69	**0.19**
30	14.15	**32.96**	8.68	**9.97**	5.43	**3.20**	4.14	**1.65**	2.65	**0.56**	1.81	**0.22**

Step 3

Step 1

Drip Irrigation

Drip Irrigation

- Has a long history in Agricultural Applications
- Often promoted as an “efficient” alternative to sprinkler or flood irrigation methods
- In Truth….
  - “Only as efficient as the design, installation and management of the system”

Components of Drip Systems

- Control Valves
- Drip Products
- Flow Meter
- Pressure Gauges
- Pressure Regulators
- Backflow Prevention Devices
- Screens & Filters
- Flushing Valves
- Injection Equipment
  - Discussed more in future workshop

Components of Drip Systems

See the publication:

Planning and Operating Orchard Drip Irrigation Systems

For guidelines on how to design your system

Drip Products

- Drip Products often used in Vineyards
  - Drip Tubing
  - Point Source Emitters

Drip Tubing

- Poly Tubing with drip emitters inside the tubing
- Common emitter spacing: 6”, 12”, 18”, 24”
- Typical Flow Rates Vary from 0.26 - 1 GPH
- Most often used for buried applications but can be suspended or placed on the surface

Point Source-Insertion Emitters

- Emitters are inserted into a poly tubing at user designed spacing's
  - Vineyard – 2 per vine is common

Point Source-Insertion Emitters

- Emitter flow rate can vary from .5 GPH to 24 GPH
- Pressure Compensating models available
- Often not rated for direct burial

Operating Pressure Requirements

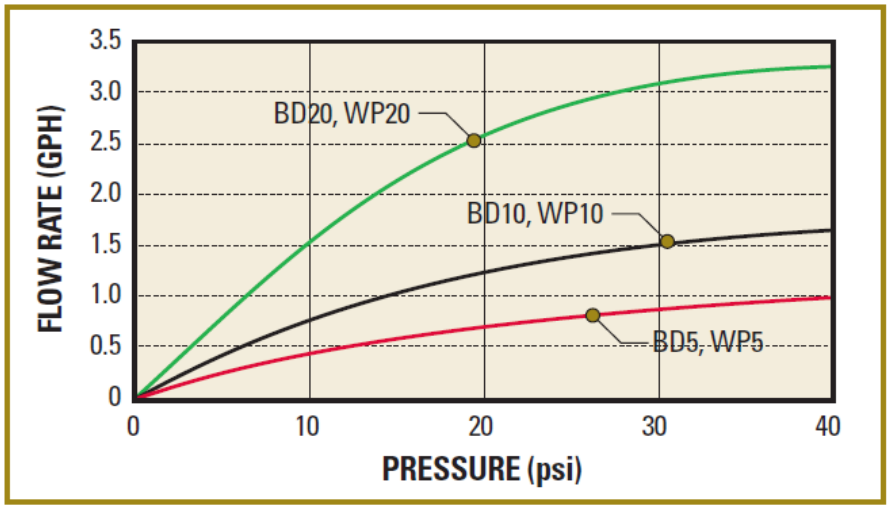
All manufacturers publish recommended operating pressures for their products

- Examples: specs for a compensating drip tubing (left) and a non-pressure compensating (right)

SPECIFICATIONS

- Flow rates: 0.5, 1.0 and 2.0 GPH
- Pressure compensation range: 14.5 to 58 psi
- Maximum pressure: 58 psi

FLOW RATE VS. PRESSURE



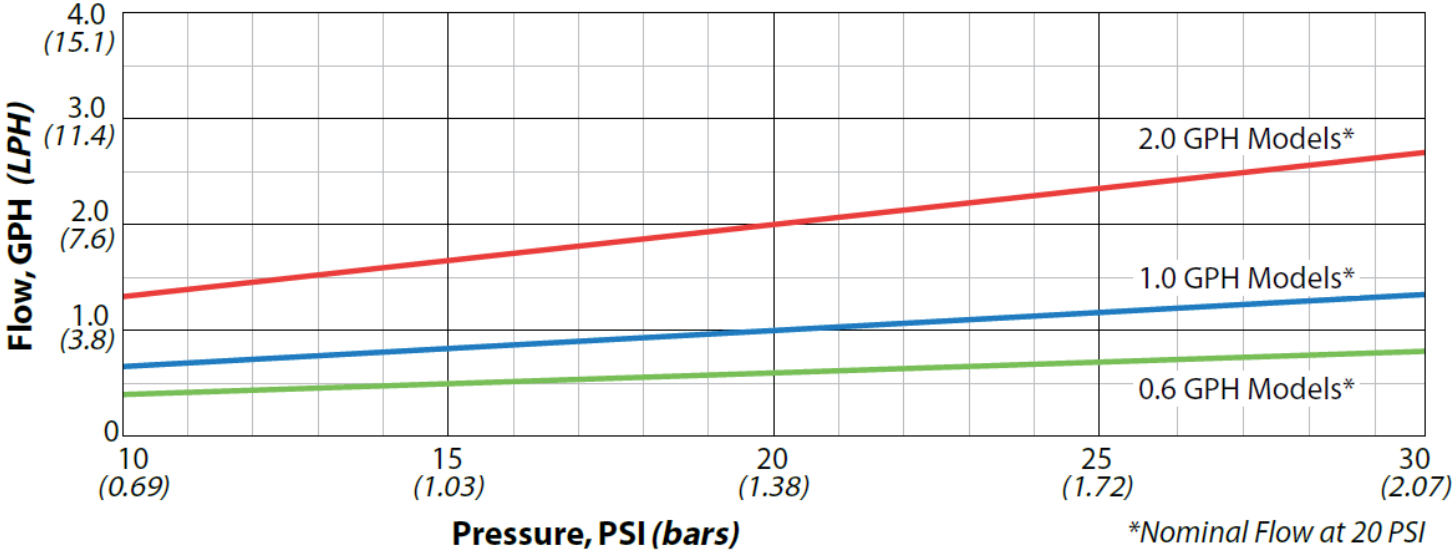
What are Pressure Compensating Emitters?

- Non-Pressure Compensating Emitters
  - Flow increases as pressure increases
  - Can result in non uniform irrigation as pressure fluctuates or system has significant friction losses
- Pressure Compensating Emitters
  - Flow remains relatively constant as pressure changes in the system

Conventional Drip Emitter, Non-Compensating

NonStop Drip Emitters

Nominal Performance



*Nominal Flow at 20 PSI

Notes

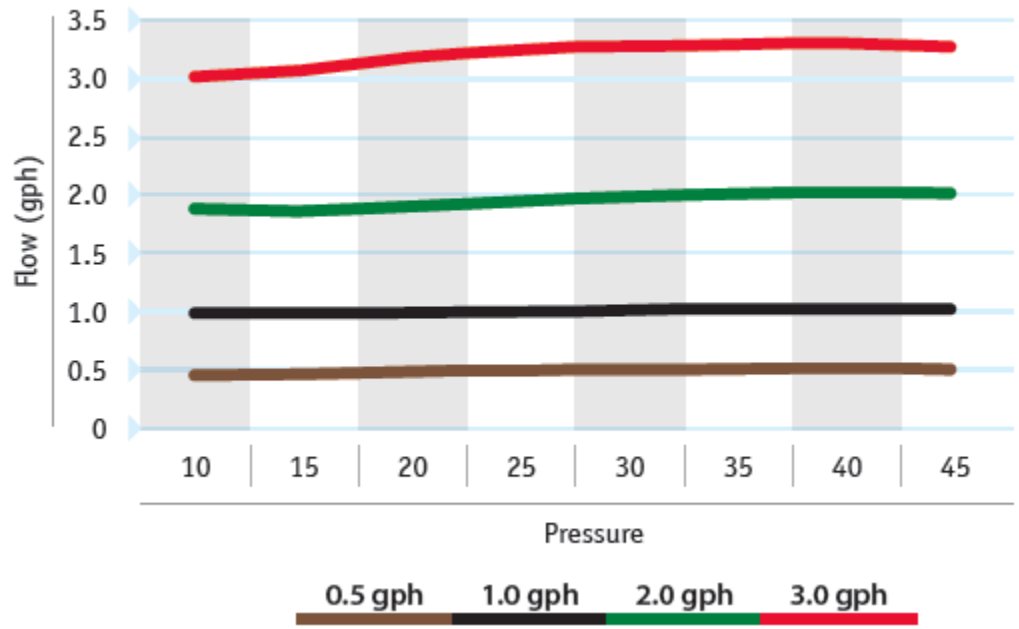
- 30-mesh filtration and 15 PSI emitter operating pressure are the recommended minimums for a NonStop emitter system.
- Manufacturer's variation, C_v: ≤ 0.05

Pressure Compensating Emitters

Emitter Flow Rate

PSI	0.5 gph	1.0 gph	2.0 gph	3.0 gph
10	0.479	1.01	1.903	3.033
15	0.488	1.003	1.881	3.088
20	0.509	1.008	1.918	3.200
25	0.518	1.030	1.971	3.269
30	0.527	1.040	2.009	3.308
35	0.530	1.047	2.032	3.299
40	0.530	1.045	2.048	3.321
45	0.528	1.045	2.036	3.290

Flow vs. Pressure



Piping Systems

- PVC Pipe
  - Most commonly used in irrigation mainlines
  - Types
    - Class/SDR
      - Wall thickness increases with diameter per class rating
      - Has a constant pressure rating per class for all diameters of pipe
    - Schedule
      - Wall thickness is fairly constant for all diameters
      - Pressure Rating Decreases as Diameter Increases
- PE - Poly – Flexible PVC Pipe
  - Flexible tubing uses to deliver water in drip systems

Drip Hose Considerations

I.P.S. Flexible PVC Tubing

Friction Loss Per 100'			
Size	GPM	Loss(psi)	Velocity(ft/s)
1/2"	2	3.5	2.5
	4	11.1	5.0
	6	26.1	7.5
3/4"	2	0.7	1.3
	4	2.1	2.5
	6	5.1	3.8
	8	8.0	5.0
	10	12.0	6.3
1"	6	1.5	2.4
	8	2.4	3.2
	10	3.5	4.0
	12	5.1	4.8
	14	6.6	5.6

Flow Meters

- Flow meters help growers monitor water usage
- System flow rates will vary based on design and number/size of emitters
- Knowing flow rates is needed for scheduling, maintenance, chemigation, etc.

Pressure Gauges

- Every Irrigation System/Station has a design pressure
- Monitoring pressure helps identify if/when maintenance maybe be needed
- Pressures > Design
  - Clogging Concern?
- Pressure < Design
  - Leak Concerns?

Backflow Prevention Assembly Devices

- Safety device which prevents the flow of water from the irrigation system back to the water source
- Typically required on systems that use potable water, groundwater or chemigation
- 4 Main Types of Backflow Devices
  - Double Check Assembly – DC
  - Spill Resistant Pressure Vacuum Breaker– SVB
  - Pressure Vacuum Breaker – PVB
  - Reduced Pressure Principle Assembly - RPZ

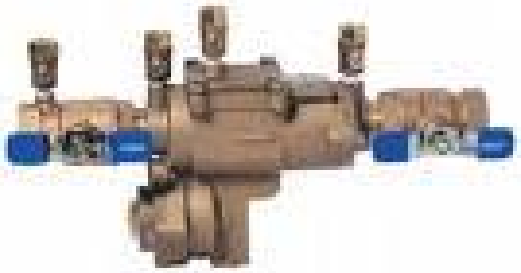
Backflow Devices

- SVB

- PVB

- DC

- RPZ



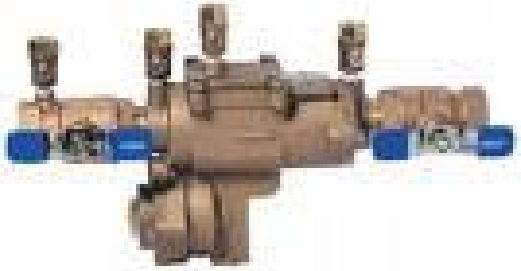
Backflow Devices

- SVB

- PVB

- DC

- RPZ*



*RPZ most commonly required if injecting chemicals into potable water, used in High Hazards

Pressure Regulators

- Drip products vary in their pressure requirements
  - 10 PSI to 50 PSI+
- Some systems require pressure regulators to achieve manufacturers recommended pressure requirement
- Some devices have pressure regulators built in
- Often installed after the station valve

Screens & Filters

- Used to catch plastic and sediment in the irrigation water
- Help Prevent clogging of emitters and valves.
- Should be checked at least seasonally for concerns

Screens & Filters

- Screen filters are used for drip systems connected to municipal water sources and other “clean” water sources such as groundwater
- Sand media filters or disc filters may be required for drip systems connected to surface water (rivers, lakes, ponds, etc.)

Filters

- Drip irrigation systems MUST include a filter
- With groundwater, a screen (mesh) filter is normally satisfactory
- Choose the mesh size of the filter using manufacturer's recommendation for the exact product being used

OPERATING SPECIFICATIONS

- Recommended pressure range: 20 to 50 PSI
- Minimum filtration 150 mesh; 100 microns

OPERATING RANGE

- Pressure: 8.5 to 60 psi (,58 to 4,14 bar)
- Flow rates: 0.6 and 0.9 gph
  (2,3 l/hr and 3,5 l/hr)
- Temperature:
  Water: Up to 100°F (37,8° C)
  Ambient: Up to 125°F (51,7° C)
- Required Filtration: 120 mesh

Valves

- Operation
  - Manual – Ball Valve
  - Electric-Solenoid
    - 24 VAC Operation from a controller

- Valve Kits Available from some manufacturers
  - Valve-Filter-Pressure Regulator

Flushing Valves

- When sediment becomes trapped in the drip product, a flushing valve is used to remove it
- Flushing valves can be automatic or manual.

Other Irrigation Methods

Flood/Furrow Irrigation

- Require proper field grading to adequately & uniformly deliver water
  - Less than 2% slope is recommended
  - Difficult to manage on greater slopes
- Can be very efficient when field can be flooded quickly (large volumes of water) for timely irrigation
- Works best for heavier soils
- NRCS has design handbooks and will help you with this

Sprinkler Irrigation

- Overhead sprinklers can be used on uneven lands and save on field grading costs
- Sprinklers may require higher pressure which increases pumping costs
- Covers a larger area of the soil and promotes good rootzones
- Can be efficiency with proper design

Sprinkler Irrigation

- Check water quality for potential for foliar damage

Table 11. Relative susceptibility of crops to foliar injury from saline sprinkling waters. (Tanji, 1990)

Na or Cl concentration (mol/m3) causing foliar injury[a]			
<5	5-10	10-20	>20
Almond	Grape	Alfalfa	Cauliflower
Apricot	Pepper	Barley	Cotton
Citrus	Potato	Corn	Sugar beet
Plum	Tomato	Cucumber	Sunflower
		Safflower	
		Sesame	
		Sorghum	

[a]Foliar injury is influenced by cultural and environmental conditions. These data are presented only as general guidelines for daytime sprinkling.

Drip Design & Installation Concepts

Design Flow - Review

- Drip design flow should match the available flow from the source (well, pump, etc.)
- Even distribution of flow among stations will result in more uniform pipe sizing and can reduce costs
- Consider any possible future expansion (future flow needs) when designing system
  - Create new stations instead of adding on to existing stations

Drip Installation

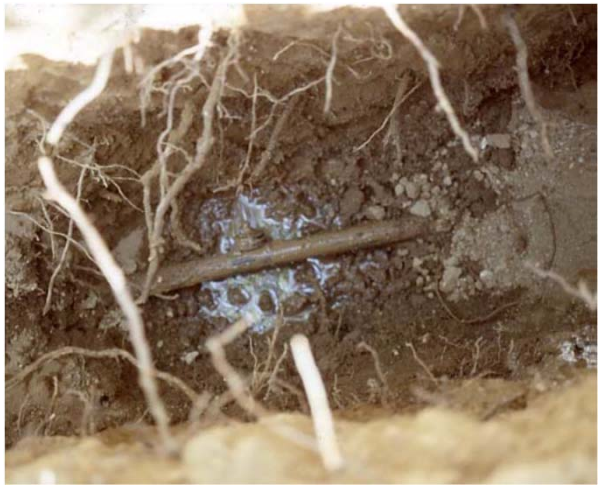
- Above Ground, attached to wire trellis
  - Often the fastest and easiest way to install
  - Allows for visual monitoring of emitters
  - Quick repairs, emitter replacement or addition
  - No worries about root intrusion
  - Needed in areas with gophers
- Water should not drip directly on the vine

Drip Installation

- Subsurface (Buried)
  - Water is applied directly in the root zone
    - Decreases runoff and evaporation
  - Protected from equipment on surface from damage
  - Repairs require digging – possible damage to roots
  - Rodent/Gopher Concerns in sandy soils?

Subsurface or Buried – Which is best?

- Both works well
- Primarily grower's preference
- Important to cover enough area for root zone development.



Drip Installation

<u>Number of Emitters Per Plant/Vine</u>

- Hydraulically does not matter
  - Large available variety of emitter flow rates allows for flexibility in total flow design
  - Example: 2 – 0.5 GPH emitters per vine is the same as 1 – 1.0 GPH emitter per vine, etc.

Drip Installation

<u>Number of Emitters Per Plant/Vine</u>

- Benefits of multiple emitters per vine
  - Distribute water evenly around the rootzone
  - Cover more soil to promote rootzones
- A common practice is to start with 1 emitter on new/young vines then expand to 2 emitters after a year or two

Drip Installation

<u>Emitter flow rates</u>

- To reduce runoff and increase infiltration
  - Use of lower flow rate emitters
    - Rocky or Heavy Soils (Clays)
    - Large Slopes
  - Use of higher flow rate emitters
      - Better on sandier soils
      - Relatively flatter fields

Example Design Scenario

Drip Irrigation Design Example

A grower is planning a new 3-acre vineyard. Based on the field size, the grower will install 40 rows of vines with 52 vines per row. Each row will be about 320 feet long.

- An existing well on the property produces 9 GPM at 40 PSI
- 2, 0.5 GPH emitters per vine

Design Questions - Calculations

1. What is the total flow rate of the field?
2. How many irrigation blocks (stations) are needed?
3. What size pipe and other irrigation components are needed?
4. What is the estimated design pressure?

Total Flow

1. 2, 0.5 GPH Emitters/Vine = 1 GPH/Vine
2. 52 Vines/Row x 1 GPH/Vine = 52 GPH/Row
3. 40 Rows x 52 GPH/Row = <u>2,080 GPH</u>

To convert GPH to GPM, divide by 60

2,080 GPH ÷ 60 = <u>34.67 GPM</u>

Flow per Irrigated Block

Since 34.67 GPM is greater than the available flow rate (9 GPM), the field will need to be divided into several irrigation blocks

$$block\ flow = \frac{Total\ Flow\ (GPM)}{Available\ Flow\ (GPM)}$$

$$\frac{34.67\ GPM}{9\ GPM} = 3.9 \sim 4 \text{ blocks}$$

Flow per Irrigation Block

Total Flow = 34.67 GPM

40 Rows of Vines

Needed: 4 Stations

1. Divide the Field into equal flows

   40 Rows of Vines ÷ 4 Stations = 10 Rows/Station

2. 10 Rows x 52 GPH/Row = 520 GPH

   520 GPH = 8.67 GPM

   or 8.67 GPM / block

Pipeline Sizing

- 8.67 GPM -> 9 GPM is required for each station
  - Use Friction Loss Charts to Size Pipelines

Irrigation Association Friction Loss Chart 2008

Class 200 PVC IPS Plastic Pipe

ANSI/ASAE S376.2 ASTM D2241 SDR 21 C=150

psi loss per 100 feet of pipe

Shown for convenience

Nominal size	Class 315 1/2"		3/4"		1"		1-1/4"		1-1/2"		2"		2-1/2"	
Avg. ID	0.696		0.910		1.169		1.482		1.700		2.129		2.581	
Pipe OD	0.840		1.050		1.315		1.660		1.900		2.375		2.875	
Avg. wall	0.072		0.070		0.073		0.089		0.100		0.123		0.147	
Min. wall	0.062		0.060		0.063		0.079		0.090		0.113		0.137	
Flow {gpm}	Velocity {ft/s}	psi loss	Velocity {ft/s}	psi loss	Velocity {ft/s}	psi loss	Velocity {ft/s}	psi loss	Velocity {ft/s}	psi loss	Velocity {ft/s}	psi loss	Velocity {ft/s}	psi loss
1	0.84	0.25	0.49	0.07	0.30	0.02	0.19	0.01	0.14	0.00				
2	1.68	0.90	0.99	0.24	0.60	0.07	0.37	0.02	0.28	0.01	0.18	0.00		
3	2.53	1.90	1.48	0.52	0.90	0.15	0.56	0.05	0.42	0.02	0.27	0.01		
4	3.37	3.24	1.97	0.88	1.19	0.26	0.74	0.08	0.56	0.04	0.36	0.01	0.24	0.01
5	4.21	4.89	2.46	1.33	1.49	0.39	0.93	0.12	0.71	0.06	0.45	0.02	0.31	0.01
6	5.05	6.86	2.96	1.86	1.79	0.55	1.11	0.17	0.85	0.09	0.54	0.03	0.37	0.01
7	5.90	9.12	3.45	2.47	2.09	0.73	1.30	0.23	0.99	0.12	0.63	0.04	0.43	0.02
8	6.74	11.68	3.94	3.17	2.39	0.94	1.49	0.30	1.13	0.15	0.72	0.05	0.49	0.02
9	7.58	14.53	4.43	3.94	2.69	1.17	1.67	0.37	1.27	0.19	0.81	0.06	0.55	0.02
10	8.42	17.66	4.93	4.79	2.99	1.42	1.86	0.45	1.41	0.23	0.90	0.08	0.61	0.03

Pipeline Sizing

- If 300 feet of pipeline is required, how much pressure loss through the pipeline?

¾” Class 200 PVC Pipe = 3.94 PSI Loss / 100 ft

$$\frac{3.94\ PSI}{100\ ft} \times 300\ ft = 11.82\ PSI\ Loss$$

- What if you upsize to 1” pipe?

1” Class 200 PVC Pipe = 1.17 PSI Loss / 100 ft

$$\frac{1.17\ PSI}{100\ ft} \times 300\ ft = 3.51\ PSI\ Loss$$

Sizing Irrigation Components

- Water Meter
- Drip Emitter
- Filter
- Valve
- Pressure Regulator?

Meter Loss

- If ¾” Meter is selected

Pressure Loss = 1.3 PSI

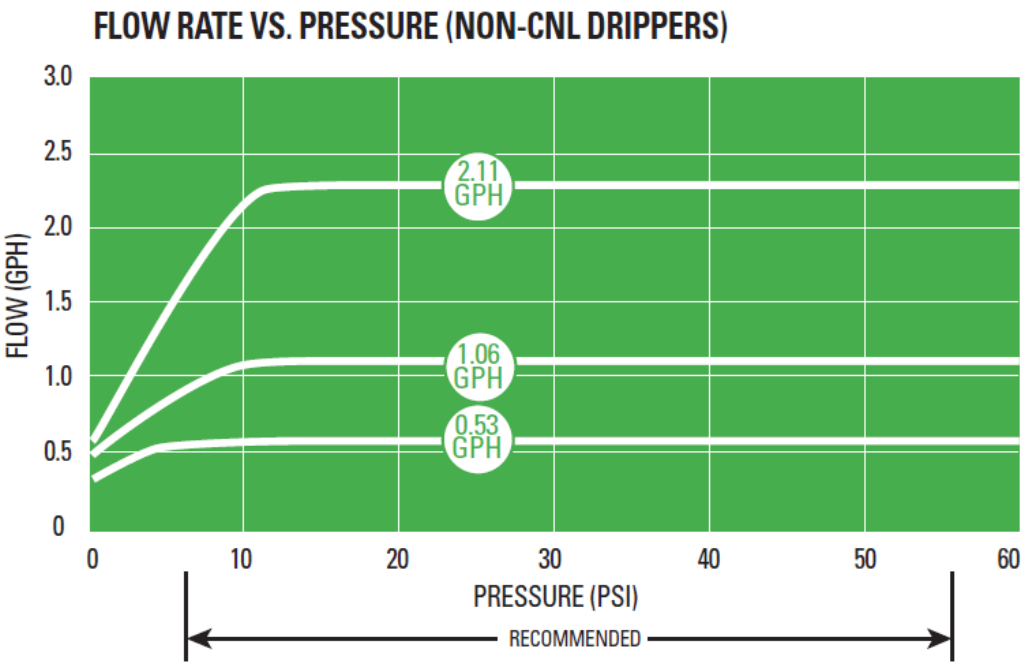
Pressure Loss Through Water Meters

Pressure Loss: psi
Nominal Size

Flow gpm	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				
9	3.0	1.3	0.6				
10	3.7	1.6	0.7				
11	4.4	1.9	0.8				
12	5.1	2.2	0.9				
13	6.1	2.6	1.0				
14	7.2	3.1	1.1				
15	8.3	3.6	1.2				

Drip Emitter

- Select Quality product from Major Manufacturer
  - Minimum 7 PSI needed for emitter operation
  - Plan for 10 PSI operation



Recommended Operating Pressure: 7 – 58 PSI

BUTTON DRIPPER (BD)

APPLICATIONS

- Vineyards
- Orchards
- Greenhouses and Nurseries

SPECIFICATIONS

- BD Outlet Hole Color and Flow: Red 0.5 GPH, Black 1.0 GPH and Green 2.0 GPH
- WP Base Color and Flow: Red 0.5 GPH, Black 1.0 GPH and Green 2.0 GPH
- Maximum Recommended Operating Pressure: 40 psi
- Recommended Filtration: 120 Mesh

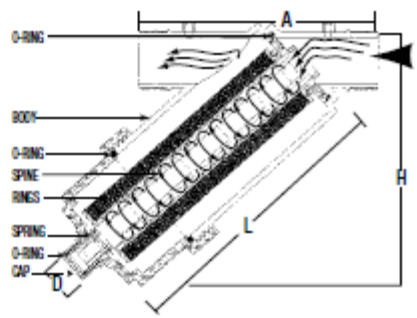
Filter

- Groundwater ~ minimal filtration
  - Screen Filter
- Follow manufacturers specs for emitter ~ 120 Mesh

SCREEN

Screen Materials:

- Cylinder: Polyester
- Screen: Polyester or Stainless Steel
- O-ring: EPDM



MODEL	DESCRIPTION	MICRON	MATERIAL	COLOR
17-120L	120 mesh, 1 1/2" long	130	stainless steel	brown
17-200L	200 mesh, 1 1/2" long	80	stainless steel	burgundy
17-085	80 mesh, 2" long	180	stainless steel	blue
17-125	120 mesh, 2" long	130	stainless steel	brown
17-160	155 mesh, 2" long	100	stainless steel	green
17-205	200 mesh, 2" long	80	stainless steel	burgundy

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- WP Base Color and Flow: Red 0.5 GPH, Black 1.0 GPH and Green 2.0 GPH
- Maximum Recommended Operating Pressure: 40 psi
- Recommended Filtration: 120 Mesh

- Normal working conditions are obtained when head loss is less than 4 PSI (0.25 BAR) with clean screen or disc element.

Valve

- 1” Valve meets flow needs
  - Pressure Loss = 3 PSI

ICV PRESSURE LOSS (AT OPTIMAL FLOWS) IN PSI

Flow (GPM)	1" Globe	1½" Globe	2" Globe	3" Globe	3" Angle
0.1	2.0				
0.5	2.0				
1	2.0				
5	2.5				
10	3.0				
15	3.0				
20	3.0	1.5			

ICV-101G

OPERATING SPECIFICATIONS

- Flow:
  - ICV-101G: 0.1 to 40 GPM
  - ICV-151G: 0.1 to 150 GPM
  - ICV-201G: 0.1 to 200 GPM
  - ICV-301: 0.1 to 300 GPM
- Recommended pressure range: 20 to 220 PSI
- Temperature rating: 150°F

Estimating Design Pressure

- Meter: 1.3 PSI
- Pipeline: 11.82 PSI
- Drip: 10 PSI
- Valve: 3 PSI
- Filter: 4 PSI

Total Pressure Required = 30.12 PSI

Well Produces: 40 PSI

Excess of 9.88 PSI ~ Should a pressure regulator be used?

Contact Information

- Dr Guy Fipps, PE
  Professor & Extension Ag Engineer
  g-fipps@tamu.edu

- Charles Swanson
  Extension Program Specialist II
  clswanson@tamu.edu
  979-845-5614