DRIP IRRIGATION WORKSHOP

Course Agenda

- Review of Hydraulics
- Determining Pressure & Friction Loss
- Overview of Drip Product and Terminology
- Drip versus Sprinkler Operation and Performance
- Defining "Efficiency" in Regards to Drip

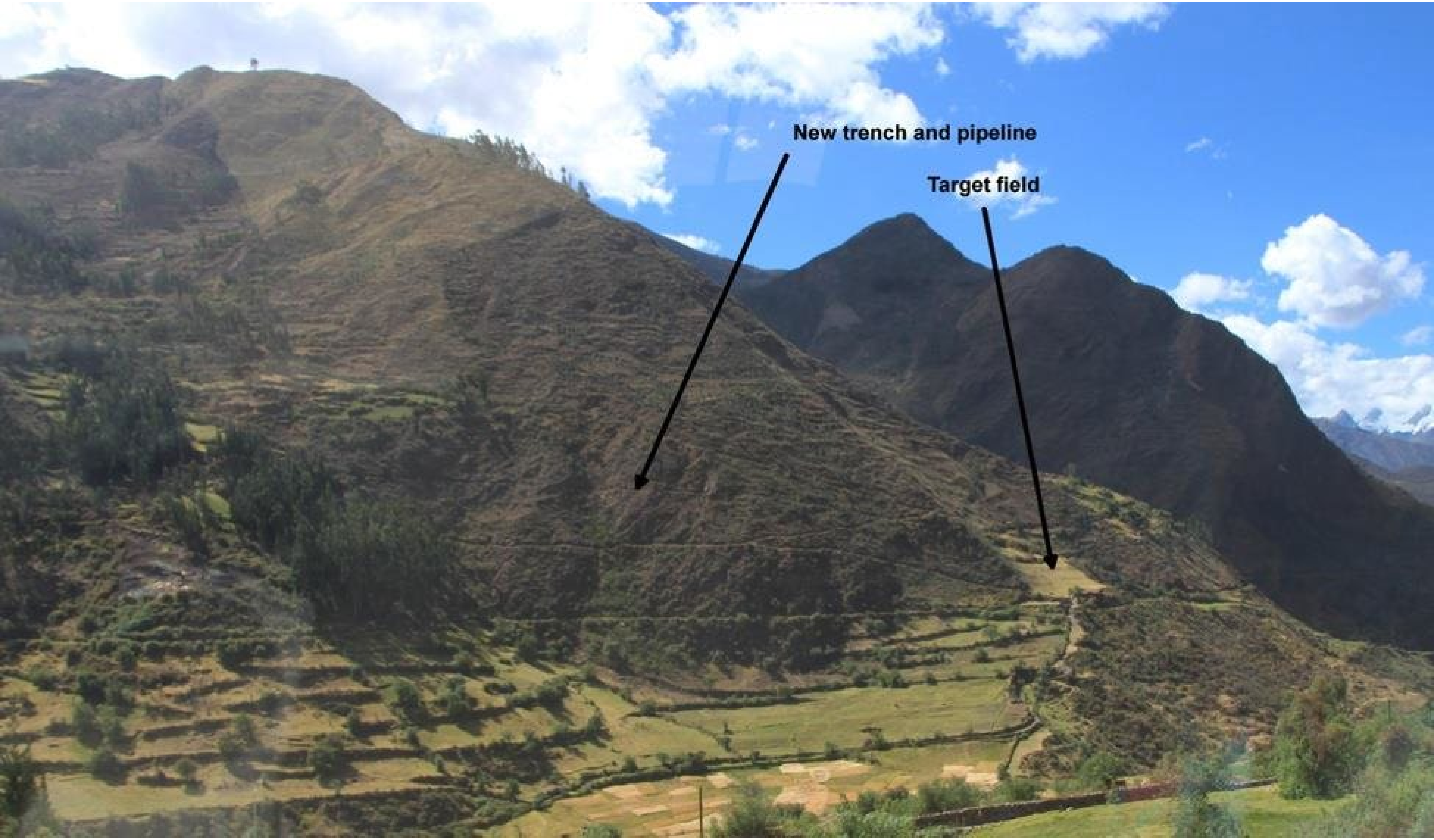
Course Agenda (cont.)

- Product Application and Specification
- Design Approach for Landscape Drip
- Practice Design
  - product selection
  - water balance and scheduling
- Clogging Detection and Control
- Soil Moisture Measurement

REAL HYDRAULIC PROBLEMS

Peru


Google earth
Bright Angel Trailhead
1.5 mile Resthouse
3 Mile Resthouse
Indian Gardens
Plateau Point
Silver Bridge
River Resthouse
Bright Angel Campground
Phantom Ranch
Legend
Bright Angel Trail
North Kaibab Trail
Plateau Point Trail
River Trail
Tonto Trail
N


New trench and pipeline
Target field

REAL HYDRAULIC PROBLEMS

Grand Canyon

Hydraulics

What is Hydraulics?

- Hydraulics is a branch of science that deals with the effects of water or other liquids in motion.
- Places emphasis on the relationship between:
  - FLOW
  - VELOCITY
  - PRESSURE.

Irrigation Hydraulics

- Is the study of waters behavior at rest (pressure) and in motion (flow)
- Irrigation Hydraulics affect:
  - Sprinkler & Drip Emitter Performance
  - Water Application Uniformity
  - Irrigation System Cost

Pressure

Pressure

- The BIGGEST variable in irrigation systems
- Determines how well sprinklers and drip components perform
- ALL manufacturers publish recommended operating pressures for their products

Types of Pressure

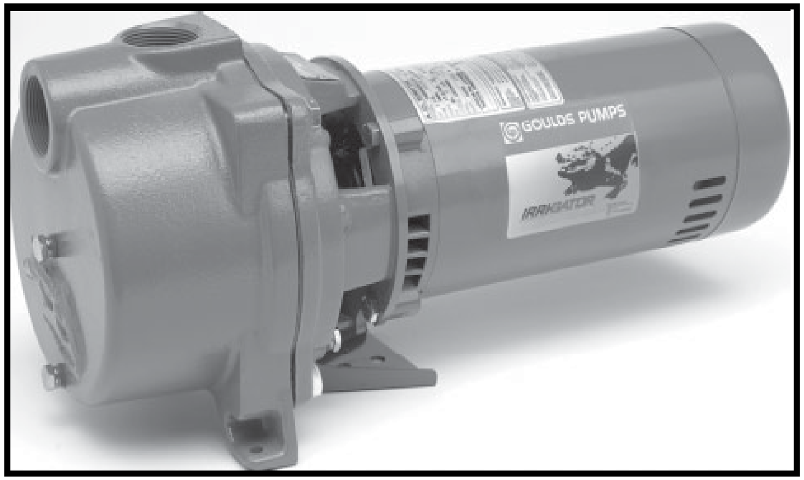
- Dynamic Pressure
  - Pressure at a point when water is moving
  - Also referred to as “operating pressure”
- Static Pressure
  - Pressure at a point when there is no water moving

Determining Pressure

- Pressure Gauges (either Static or Dynamic)

How is pressure created?

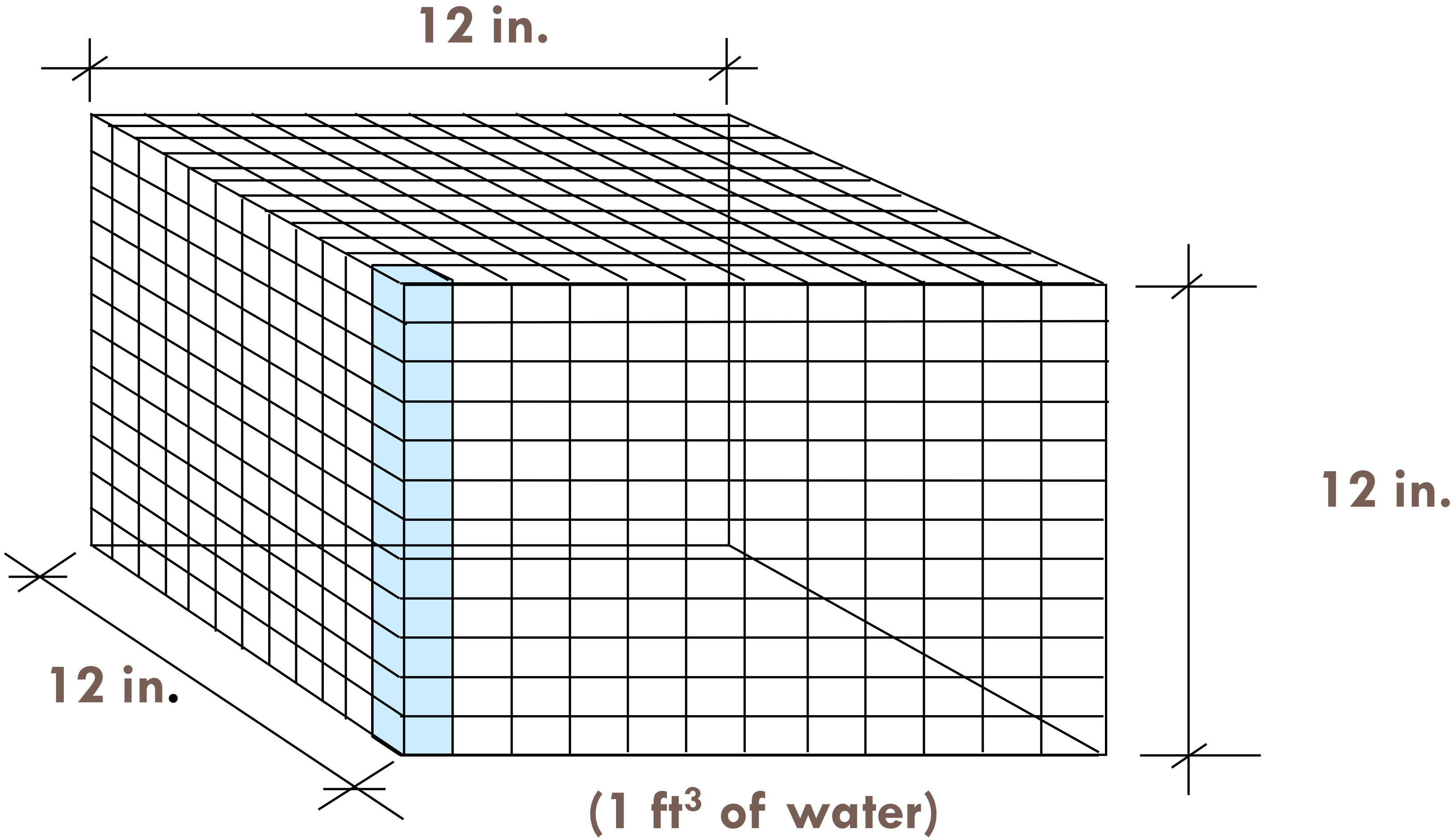
- Weight of the Water (Gravity)
- Mechanical Means (Pump)



How do we measure pressure?

- PSI
  - Pounds Per Square Inch
- Feet of Head
  - Height of Water in a column

Column of Water



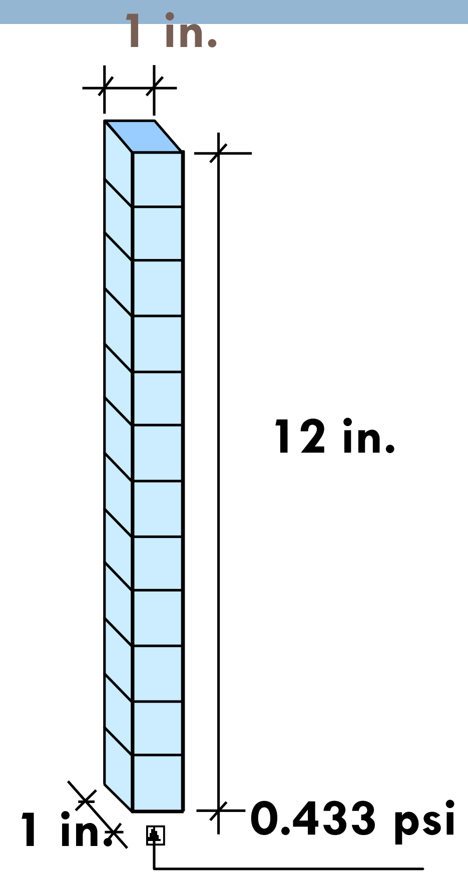
(1 ft^3 of water)

Relationship between PSI & Feet of Head

- 1 PSI = 2.31 Feet of Head
- 1 Foot of Head = .433 PSI

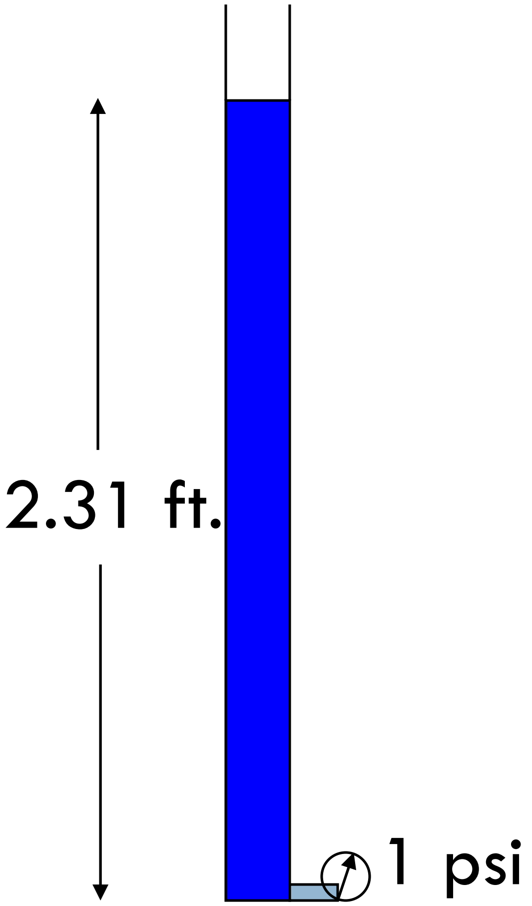
Water Pressure from 1 Foot of Water

- **1 Foot of head = 0.433 psi**

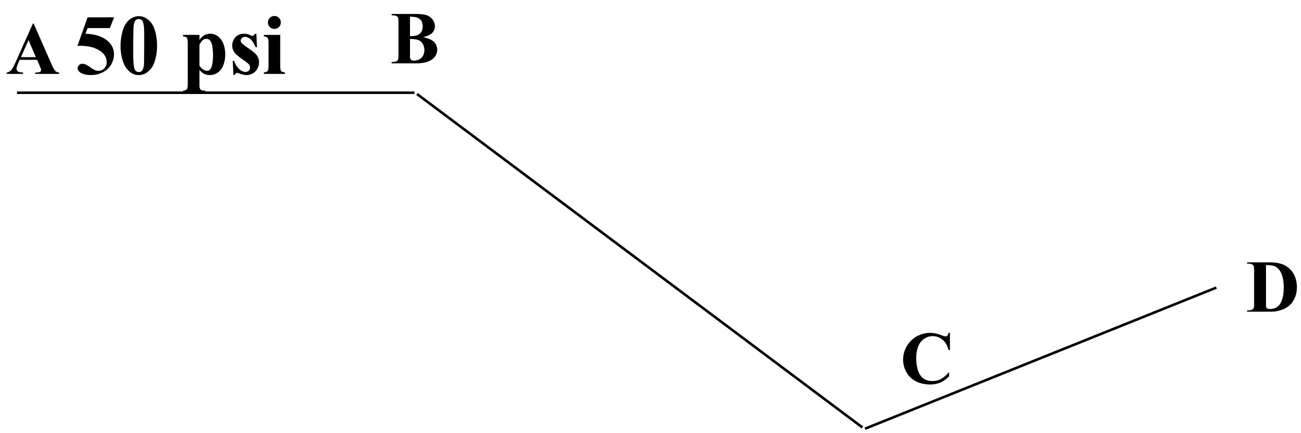


Feet of Head from 1 psi

- **1 psi = 2.31 ft. of head**



Static Pressure and Elevation



- A and B are at same elevation: static pressure at B = A
- C is lower in elevation than B: static pressure at C is higher that at B
- D is at higher elevation than C: static pressure at D is lower than at C

Flow

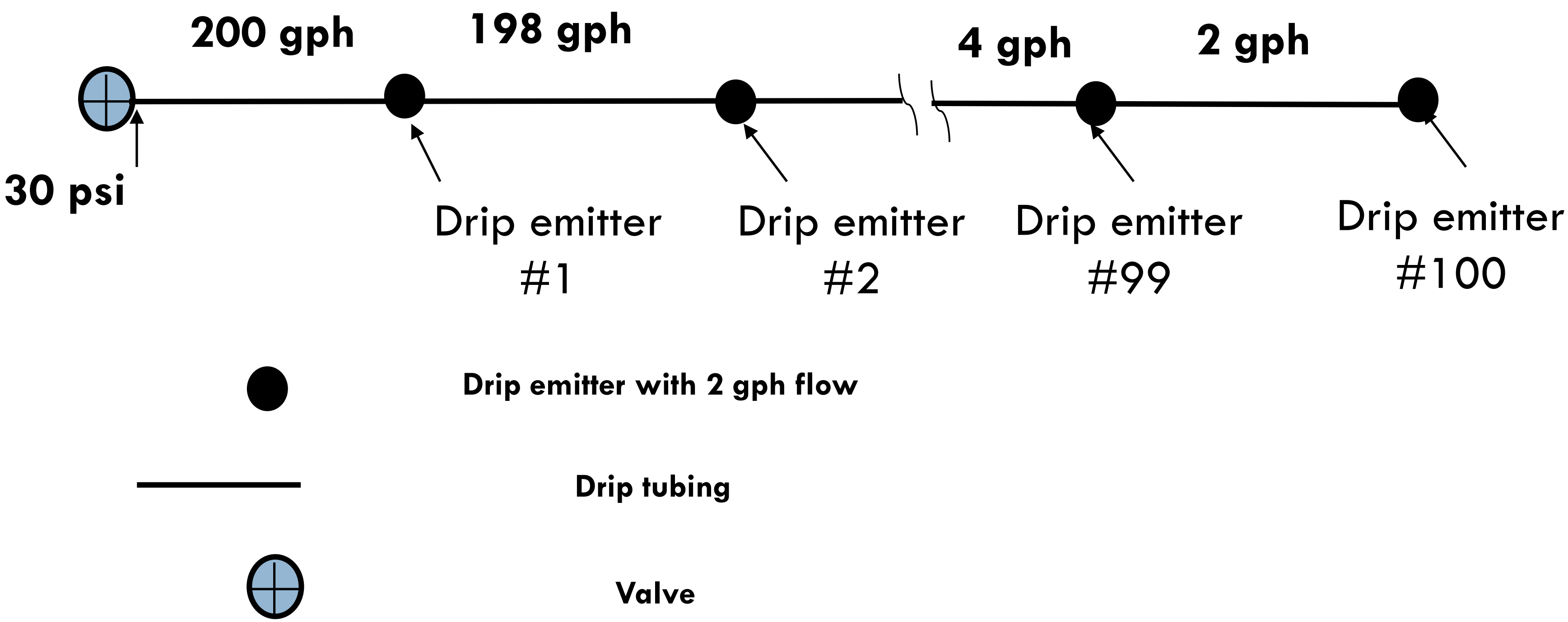
Water Movement in the System

- **Flow**: amount (volume) of water moving per unit of time. Measured in:
  - Gallons per minute (gpm)
  - Gallons per hour (gph)
- **Velocity**: speed of moving water. Measured in:
  - Feet per second (fps)

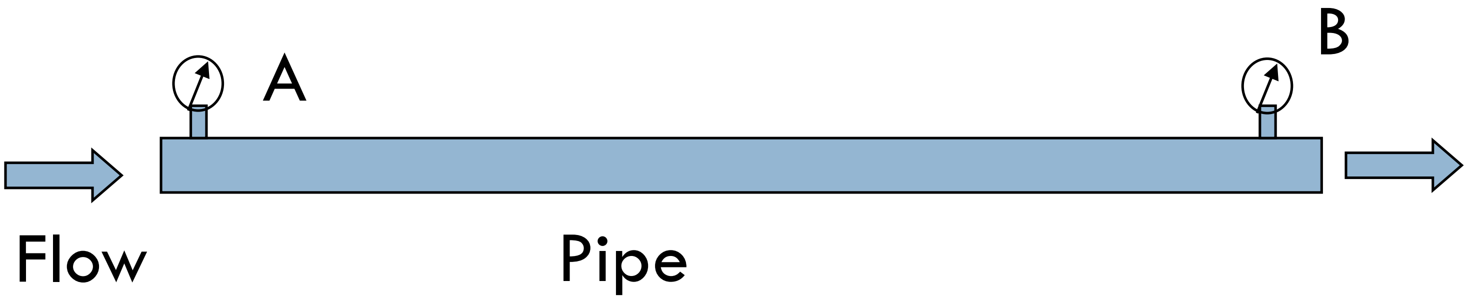
Flow

- **Flow** in a system is dependent upon the number of sprinklers or drip emitters working at the same time
- **Flow** in various pipe segments of an irrigation system can be different
- **Flow** is commonly measured in gpm for sprinkler systems and in gph for drip irrigation systems

Flow for a Basic Drip System



Introduction to Friction Loss (Pressure Loss)



- When water is **not moving** there is **no friction loss** – this is static pressure
- When water **is moving** there is **some loss of pressure due to friction.**

What Affects Friction Loss?

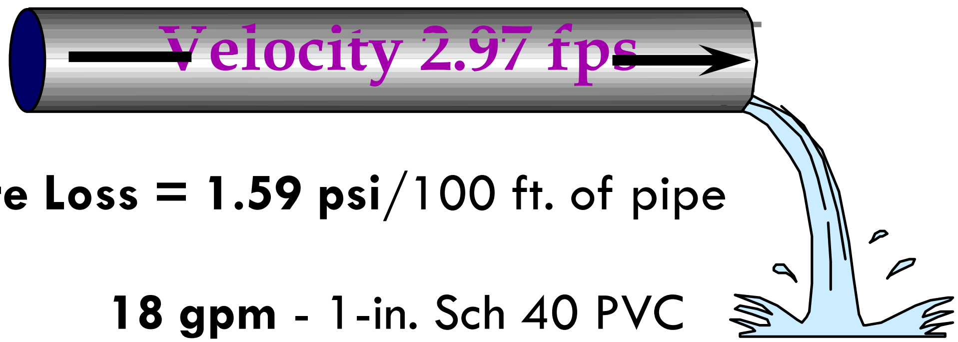
- **Velocity (flow)**
- **Inside diameter of pipe (ID)**
- **Roughness of material**
- **Length of pipe**

Classifications of Pipe (PVC)

- Schedule Pipe
  - Pipe wall thickness is fairly constant for all diameters
  - Pressure Rating Decreases as Diameter Increases
- Class/SDR Pipe
  - Has a constant pressure rating per class for all diameters of pipe
  - Wall thickness changes with pipe diameter

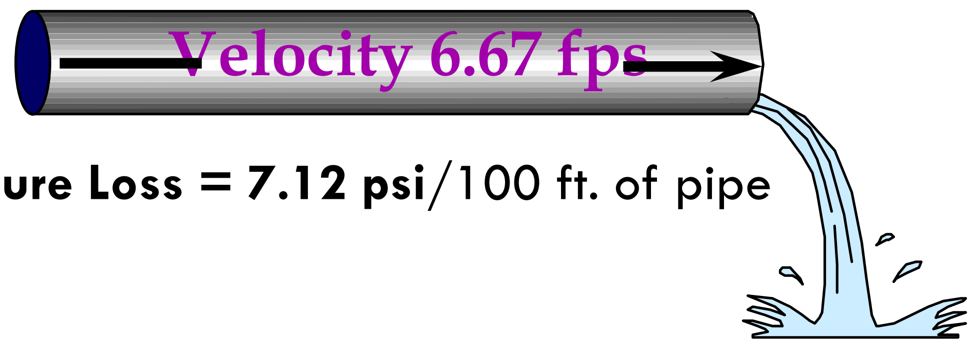
Velocity (flow)

8 gpm - 1-in. Sch 40 PVC



Pressure Loss = 1.59 psi/100 ft. of pipe

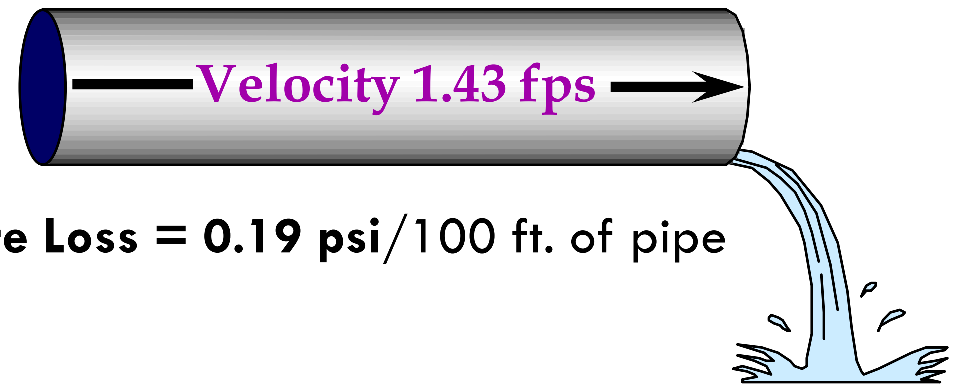
18 gpm - 1-in. Sch 40 PVC



Pressure Loss = 7.12 psi/100 ft. of pipe

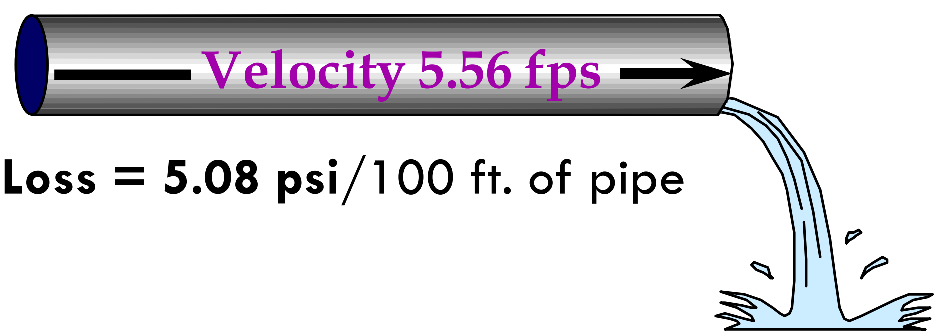
Inside Diameter

15 gpm - **2-in. (2.067 in. Inside Diameter)** Sch 40 PVC



Pressure Loss = 0.19 psi/100 ft. of pipe

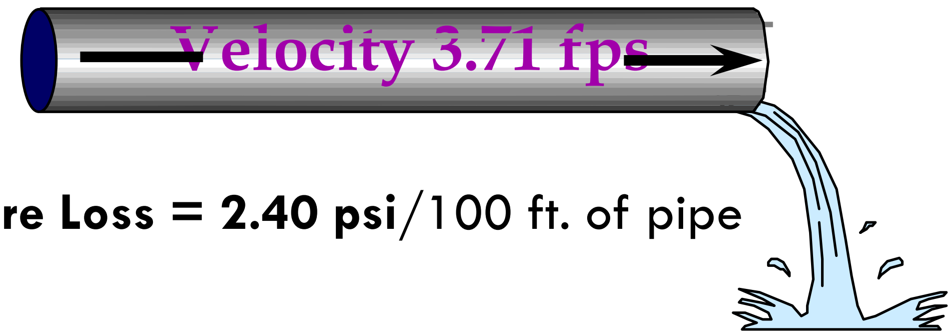
15 gpm - **1-in. (1.049 in. Inside Diameter)** Sch 40 PVC



Pressure Loss = 5.08 psi/100 ft. of pipe

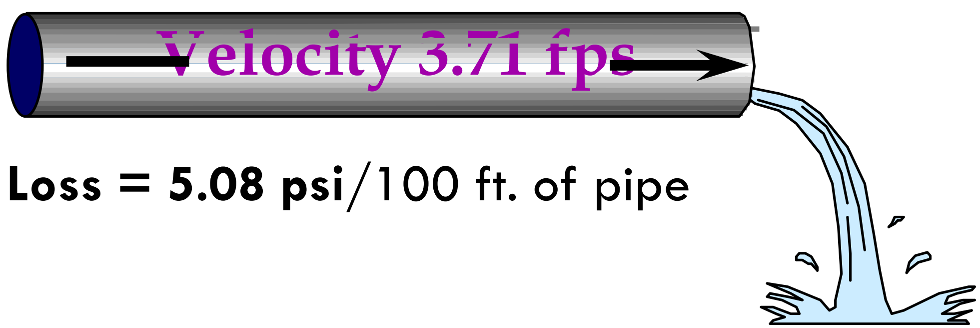
Roughness

10 gpm - 1-in. **Sch 40 PVC (Roughness C=150)**



Pressure Loss = 2.40 psi/100 ft. of pipe

10 gpm - 1-in. **Sch 40 Standard Steel Pipe (Roughness C=100)**

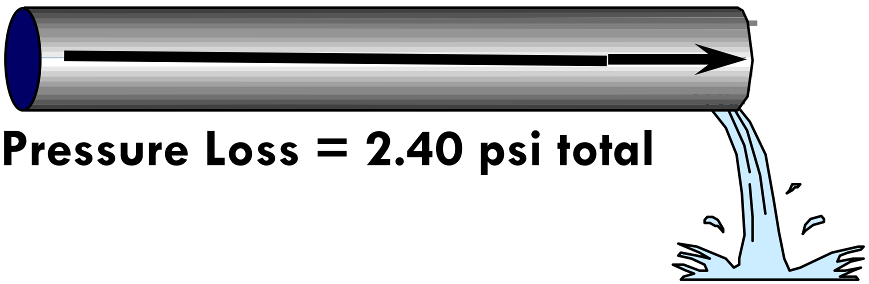


Pressure Loss = 5.08 psi/100 ft. of pipe

Length

10 gpm - 1-in. Sch 40 PVC

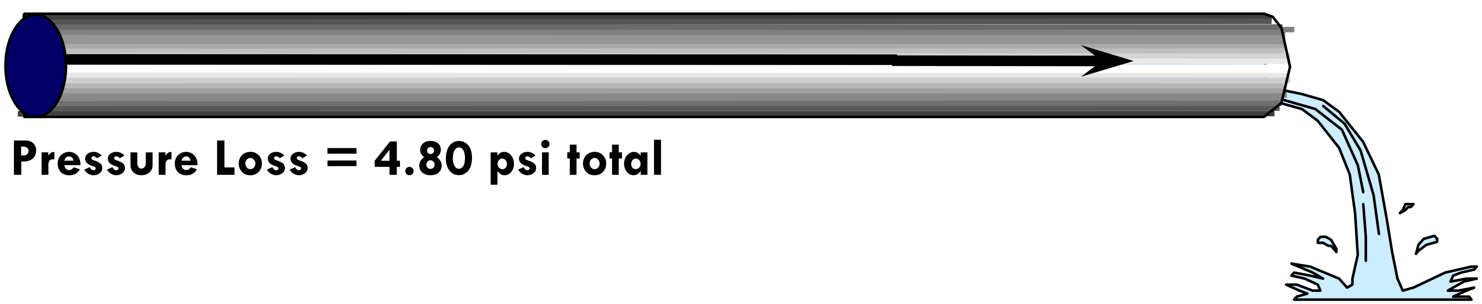
100 feet of pipe



Pressure Loss = 2.40 psi total

10 gpm - 1-in. Sch 40 PVC

200 feet of pipe



Pressure Loss = 4.80 psi total

How to Find Friction Losses

- **Use Formula**
  - Hazen-Williams
  - Darcy-Weisbach
  - Manning (mainly used for open channel flow)
  - Others
- **Use Tables**
  - Generally calculated using Hazen-Williams formula

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	[illegible]	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	[illegible]	[illegible]	0.01	0.14	0.00	0.09	0.00	0.06	0.00
2	0.94	0.22	0.58	[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	0.90	[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	1.36	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	8.66	9.97	5.43	3.20	4.14	1.65	2.65	0.56	1.81	0.22

To Use Friction Loss Tables:

- **Find proper page for pipe material and type.** Note - all tables are for 100-ft. pipe length.
- **Find the flow (gpm)**
- **Find the size of pipe**
- **Find the psi loss** corresponding to pipe size under psi loss column
- **Find the corresponding row for flow**

Example: Friction Loss Calculation Using the Tables

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

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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
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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
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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

Introduction to Dynamic Pressure

- Pressure when water is moving
- Uniformity of the irrigation system is dependent upon the correct dynamic pressure

Factors Affecting Dynamic Pressure

- **Change in elevation**
  - Same as in static pressure
- **Friction loss in various components**
  - Loss of pressure as water flows in pipes and other irrigation components
- **Others factors**
  - velocity head and entrance losses (not covered in this presentation)

Dynamic Pressure Calculation

- When calculating dynamic pressure, consider:
  - Pressure at the water source
  - Changes in elevation
  - Friction losses in irrigation system components

Friction Losses for Pipe Fittings

- Separate tables are available for friction losses in fittings
- Sometimes a certain percentage (10% - 20%) of pipe friction loss is used to account for fittings friction losses

Friction Losses for Other System Components

- See tables and charts in manufacturer's catalogs for other components such as valves, filters etc.
- Use a water meter table for finding friction loss through the water meter (if there is one in your system)

Typical Pressures and Flows for Sprinkler Irrigation

Sprinkler Type	Radius of Throw	Pressure Ranges	Flow Ranges
Spray	5 to 16 ft.	15 to 30 psi	Up to 4 gpm
Small Rotors	15 to 30 ft.	25 to 55 psi	Up to 6 gpm
Medium Rotors	30 to 50 ft	25 to 65 psi	Up to 10 gpm
Large Rotors	50 ft. +	50 to 120 psi	10 to 40+ gpm
Guns	100 ft. +	100 psi +	80 gpm +

Typical Pressures and Flows for Drip Irrigation

Drip Type	Pressure Ranges	Flow Ranges
On-line Drip Emitters	10 to 50 psi	0.5 to 24 gph
Inline Drip Emitters	10 to 50 psi	0.4 to 0.9 gph
Mini sprays/ Spitters	10 to 50 psi	0 to 30 gph
Drip Tape	8 to 20 psi	10 to 60 gph per 100 ft. of tape

Irrigation Hydraulics Summary

- Static pressure is affected by:
  - Elevation only
- Dynamic pressure is affected by:
  - Elevation
  - Friction losses in pipe
  - Friction losses in fittings
  - Friction losses in all other components

Summary (cont.)

- **Irrigation hydraulics:**
  - Determines pressure available at the emission device
  - Determines flow in the pipe
  - Helps design efficient, economical systems

Sizing Mainlines and Laterals

Irrigation Pipe Sizing

- Balance between excessive cost and excessive velocity or pressure loss
- **Friction Factor** Method
  - Lateral Lines
  - Maintains Pressure Uniformity
- **Velocity Limit** Method
  - Mainlines
  - Reduces Potential For Water Hammer

Irrigation Pipe Sizing

- Before pipe can be sized, you must:
  - Determine Design Capacity and Available Pressure
  - Select and Place Sprinklers/Drip Product on Plan
  - Divide plan into zones so total flow does not exceed design capacity
  - Select valves and other devices
  - Determine Length of Mainlines and Laterals

Velocity Limit Pipe Sizing

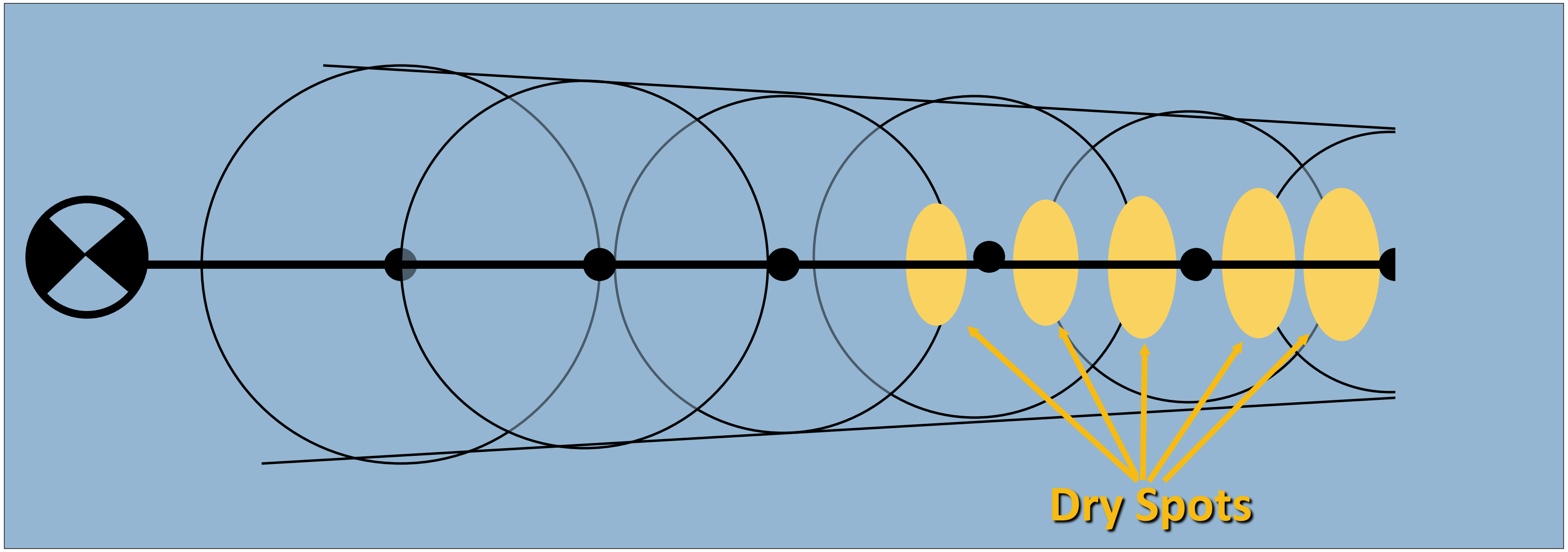
Maximum PVC Mainline Flow Rates*

Pipe Size and Type	Maximum Flow Rate At 5 ft/s
1/2" Schedule 40 PVC	4.7 gpm
3/4" Schedule 40 PVC	8.3 gpm
1" Schedule 40 PVC	13.5 gpm
1-1/4" Schedule 40 PVC	23.4 gpm
1-1/2" Schedule 40 PVC	31.8 gpm
2" Class 315 PVC	50.2 gpm
2-1/2" Class 315 PVC	73.5 gpm
3" Class 315 PVC	109 gpm

•If other pipe types are used, maximum flow rates determined by appropriate velocity for pipe type.

Excessive Friction (Pressure) Loss

- Results in Decreased Uniformity and Precipitation Rate



Drip Irrigation

Drip Irrigation

- Application of water at very low flow rates
- Also referred to as “low volume” and “low flow” irrigation
- Sometimes referred to as “Micro Irrigation”

Drip Irrigation

- Irrigation water is applied through emitters either above or below the soil surface
- Precipitation rates vary with length, pressure and flow.

Drip Irrigation (cont.)

- Long history in agricultural applications
- Promoted as an “efficient” alternative to sprinkler irrigation
- In truth:
  “**Only as efficient as the person behind the design and management**”

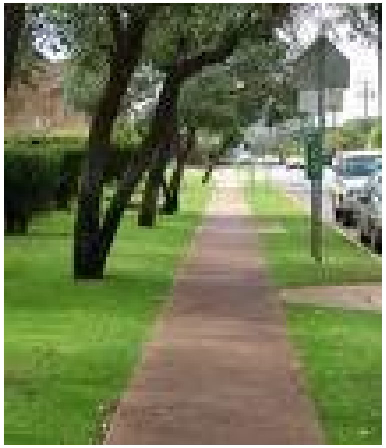
State Irrigation Regulations

- *§344.62.Minimum Design and Installation Requirements.*

"New irrigation systems shall not utilize above-ground spray emission devices in landscapes that are less than 48 inches not including the impervious surfaces in either length or width and which contain impervious pedestrian or vehicular traffic surfaces along two or more perimeters. "

48 Inch Rule, 5ft Rule

- Example: the landscape between roads and sidewalks



Types of Drip

Types of Drip Products

- Three Main types of Drip:
  - Tape
  - Tubing with Embedded Emitters
  - Poly pipe with emitter inserts

Drip Products – Drip Tape

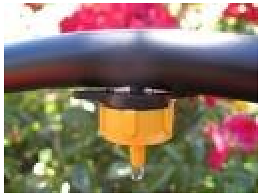
- Thin Wall Flat Drip Tape
  - Contains embedded emitters
  - Operates Under Low Pressure Conditions
  - Popular in vegetable production

Drip Products – Drip Tubing With Embedded Emitters

- Durable Thick Wall Tubing
- Usually contain pressure compensating embedded emitters
- Can operate under higher pressures

Drip Products – Drip Tubing with Inserted Emitters

- Uses hard hose PE tubing
- Allows for precision application of water
- Flexible Precipitation Rates, based on emitter
- Used for Shrubs and Trees



Terminology

- "On-line" emitters - emitters attached to the outside of the supply tubing with a barbed inlet projecting into the tube.
- Usually installed on-site to customize for various planting layouts

On Line Emitters

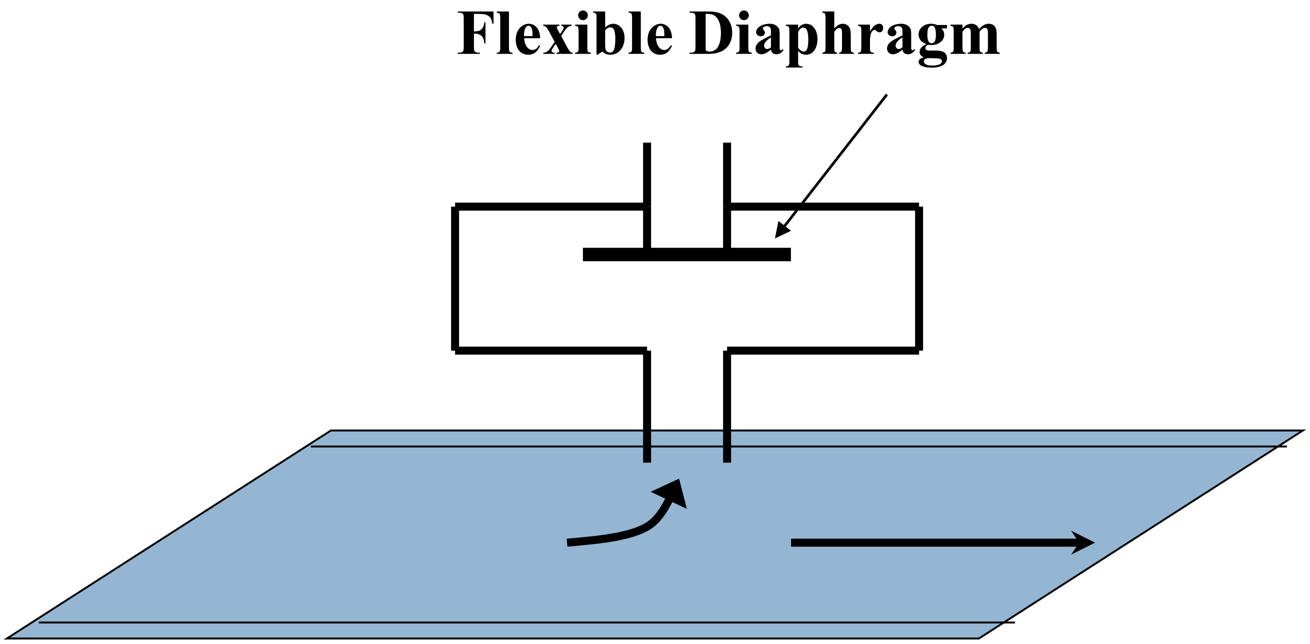
Terminology (cont.)

- "In-line" emitter - emitter is imbedded inside drip tubing or tape
- Installed at uniform intervals during the manufacturing process

In-Line Emitter

Terminology (cont.)

- "Pressure compensating emitters" - flow remains constant with varying inlet pressures
- Disc or rubber diaphragm located inside the emitter closes slightly as pressure increases … reducing the cross sectional area, thus reducing flow



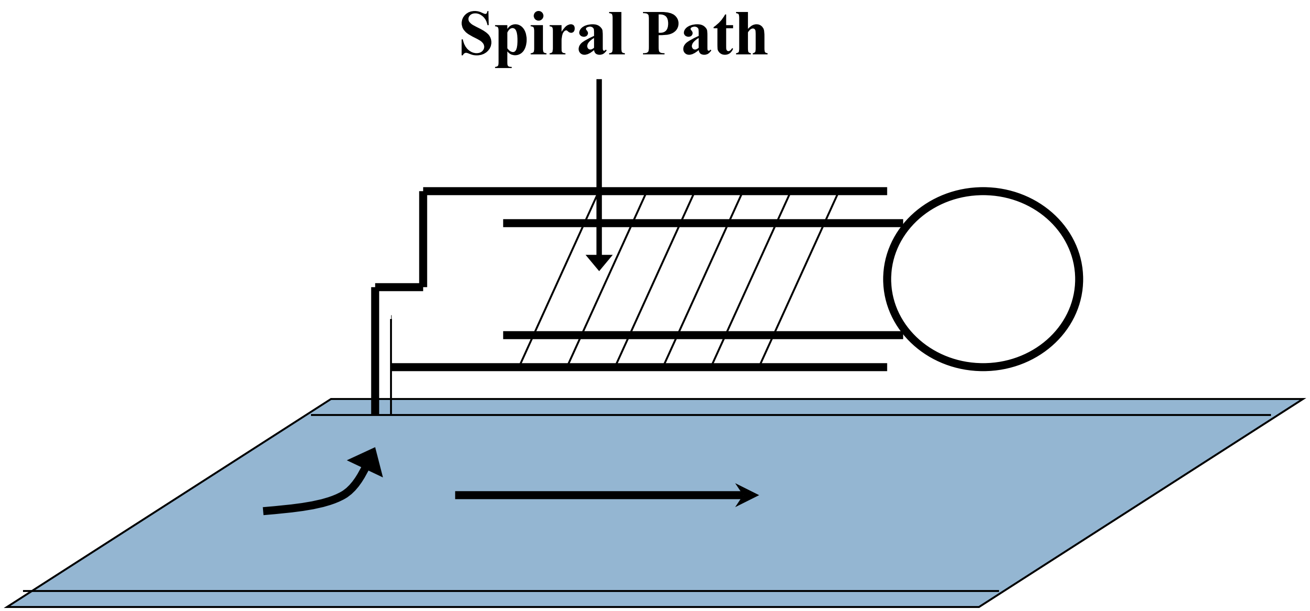
Pressure Compensating Emitter

Terminology (cont.)

- "Non-pressure compensating emitters" - flow rate increase with increasing inlet pressures
- Usually constructed entirely of plastic with no moving parts

Terminology (cont.)

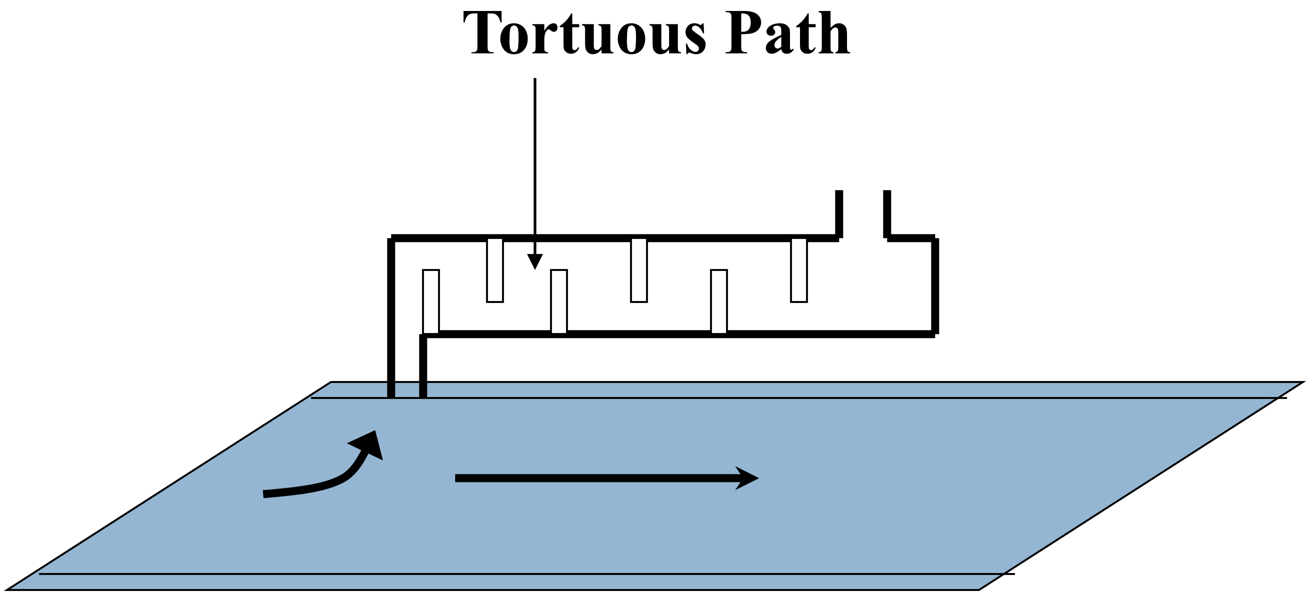
- "Laminar flow" - water travels through a long, smooth, spiral flow path through the emitter



Long - spiral - path Emitter

Terminology (cont.)

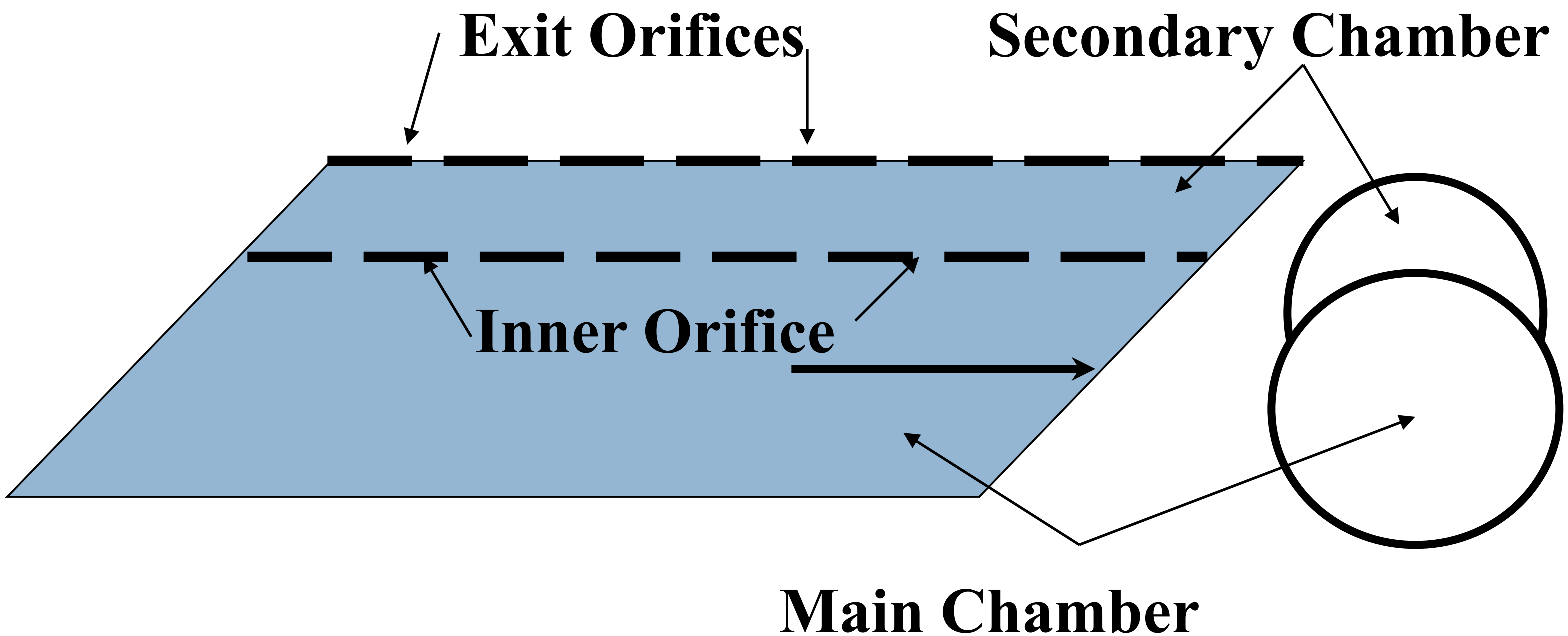
- "Tortuous" or "Turbulent" flow - water travels through a maze of pathways before reaching the outlet
- Requires less filtration than laminar flow



Tortuous Flow Emitter

Terminology (cont.)

- "Self-flushing" - water travels through the emitter at high velocity during start-up to remove debri
- Should not be regarded as a substitute for a filtration device
- Newer designs have flexible emitters that self-flush when plugged



Twin - Chamber Tubing

Components of Drip Systems

- Manual or Remote Valve
- Drip Products
- Pressure Regulators
- Backflow Prevention Devices
- Screens & Filters
- Flushing Valves

Backflow Prevention Assembly Devices

- Safety device which prevents the flow of water from the irrigation system back to the water source,
- 4 Main Types of Backflow Devices
  - Atmospheric Vacuum Breaker – AVB
  - Double Check Assembly – DC
  - Pressure Vacuum Breaker – PVB
  - Reduced Pressure Principle Assembly - RPZ

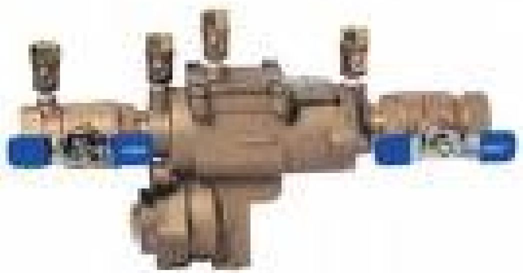
Backflow Devices

- AVB

- PVB

- DC

- RPZ



Pressure Regulators

- Some systems require pressure regulators to achieve manufacturers recommended pressure requirement
- Some devices have pressure regulators built in

Screens & Filters

- Used to catch plastic and sediment in the irrigation water
- Prevent clogging of emitters and valves.

Screens & Filters

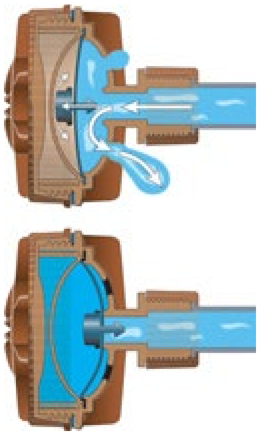
- Screen filters are used for drip systems connected to municipal water sources and other "clean" water sources
- Sand media filters or disc filters may be required for drip systems connected to surface water (rivers, lakes, ponds, etc.)

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

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.



Operational Indicators

- Flags
- Misters
- Indicators
- Capped Spray Body
  - Can be used a visual indicators that a drip system is operating





Valve & Valve Kits

- Select valves that can operate at very low flow rates
  - 0.2-0.5 minimum available
- Manufacturers sell drip valve kits that combine low flow valves with filters and pressure regulators

Special Equipment Needs

- Controllers
  - Long timing capabilities (0 - 9.9 hours)
  - Cycle/Soak (Stacked timing availability)
  - Calendar options (for specific days of the week)
  - Remote sensor circuit (for use with moisture sensors)

Special Equipment Needs (cont.)

- Solenoid Valves
  - Must open and close at low flow rates
- Filtration Device
  - Screen, disk, wye
  - Mesh size depends on water quality and emitter characteristics

Special Equipment Needs (cont.)

- Pressure Regulation Device
  - Placed on the discharge side of the filtration device
  - Placement in respect to the solenoid valve should follow valve manufacturer's specifications

Special Equipment Needs (cont.)

- Pressure Gage
  - detects emitter clogging
  - detects leaks in connections and lateral tubing
- Flow Meter
  - detects emitter clogging
  - detects leaks in connections and lateral tubing

Special Equipment Needs (cont.)

- Soil Moisture Sensors
  - useful for maintaining optimum moisture levels and irrigation scheduling (especially when used with subsurface installations)

Advantages of Drip

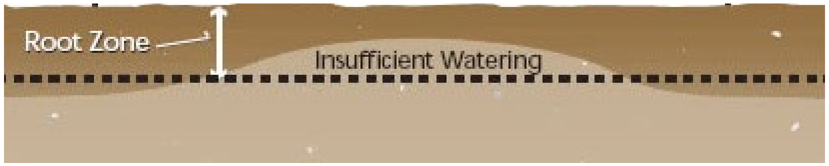
Advantages

- Low Evaporation Loss
  - Water is being applied at the soil surface, not in the air
- No wind drift loss

- Low runoff potential

Advantages

- Precise soil moisture control
  - Apply water directly to the soil and/or root zone



- Requires less water pressure

Advantages (cont.)

- Smaller pipe size requirements
- Reduced weed growth when used with a mulch
- Reduced liability due to water on hardscapes
- Improved performance for plants on steep slopes

Benefits of Drip

- Allows for areas to be irrigated more efficiently that couldn't before
  - Slopes
  - Thin areas
- Low flow rate allows for larger areas to be irrigated at the same time.
- Ability to irrigate when the site may be in use

Disadvantages of Drip

Disadvantages

- Requires constant monitoring and maintenance
- May be cost prohibitive for large landscape areas (I.e., turfgrass)
- Applies a limited supply of water into the root zone
  - May require long runtimes

Disadvantages (cont.)

- Requires filtration and pressure regulation
- Surface tape and tubing are more susceptible to pests and vandalism
  - Rodents and Gophers like to chew on buried products

- Subsurface installations may reduce customer confidence
  - Typically cant see it operating, owners want to see what they paid for

Product Selection

Understanding Manufacturers Literature

Drip Products

- Options:
  - Wall thickness
  - Diameter
  - Emitter spacing
  - Flow rates

Drip Installation

- Installation can be done by hand or tractor
- Numerous drip guides on the web

Drip Selection

- Use products from major manufacturers if possible
- Thinner material (wall thickness) and smaller diameters are less expensive
- Thicker products are more durable
- For drip under plastic mulch, the thinner products are typically used

Drip Specification Charts

- Charts typically give the following for each drip tape product:
  - diameter (inch, mm)
  - in-let pressure
  - flow rate

Drip Specification Charts

- In-let pressures are listed usually as a range from the minimum to the maximum for each tape product (psi, bar)
- Flow rates are usually given as:
  - GPH/100’ (gallons per hour per 100 ft of tape)

    or
  - GPH per emitter

Maximum Length of Run

- EU (emission uniformity) is a measurement of how evenly water is distributed along the tape
- the longer tape is run, the lower the EU
  - Due to friction loss in the product
- If possible, use row lengths that maintain 90% EU

Maximum Length of Run

- The maximum distance that the drip tape can be run varies according to
  - diameter
  - in-let pressure
  - flow rate
  - slope (%)

Rainbird Example

Inlet Pressure psi	XF Dripline Maximum Lateral Lengths (Feet)					
	12″ Spacing		18″ Spacing		24″ Spacing	
	Nominal Flow (GPH)		Nominal Flow (GPH)		Nominal Flow (GPH)	
	0.6	0.9	0.6	0.9	0.6	0.9
15	255	194	357	273	448	343
20	291	220	408	313	514	394
30	350	266	494	378	622	478
40	396	302	560	428	705	541
50	434	333	614	470	775	594

XF-SDI Dripline Flow (per 100 feet)				
Emitter Spacing	0.6 GPH Emitter		0.9 GPH Emitter	
12″	61.0 GPH	1.02 GPM	92.0 GPH	1.53 GPM
18″	41.0 GPH	0.68 GPM	61.0 GPH	1.02 GPM
24″	31.0 GPH	0.51 GPM	46.0 GPH	0.77 GPM

Rainbird Example

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

Netafim Example: Techline CV

Maximum Length of a Single Lateral *(feet)*

Dripper Spacing		12"				18"				24"	
Dripper Flow Rate *(GPH)*		**0.26**	**0.4**	**0.6**	**0.9**	**0.26**	**0.4**	**0.6**	**0.9**	**0.6**	**0.9**
Inlet Pressure	**20 psi**	367	277	218	166	502	323	299	227	283	373
	25 psi	427	325	256	194	604	459	361	274	458	348
	35 psi	539	409	322	244	763	579	456	346	580	440
	45 psi	618	469	369	280	877	664	523	397	666	506

Flow per 100 Feet

Dripper Spacing	**0.26 Dripper**		**0.4 Dripper**		**0.6 Dripper**		**0.9 Dripper**	
	GPH	**GPM**	**GPH**	**GPM**	**GPH**	**GPM**	**GPH**	**GPM**
12"	26.40	0.44	40.00	0.67	61.00	1.02	92.00	1.53
18"	17.58	0.29	26.67	0.44	41.00	0.68	61.00	1.02
24"	Not Available		Not Available		31.00	0.51	46.00	0.77

Netafim Example: Techline CV

SPECIFICATIONS

- Broadest choice of dripper flow rates: 0.26, 0.4, 0.6 and 0.9 GPH
- Dripper spacings: 12″, 18″ and 24″ (24″ spacing available for 0.6 and 0.9 GPH only)
- Pressure compensation range: 14.7 to 70 psi (stainless steel clamps recommended above 50 psi)
- Bending radius: 7″
- Maximum recommended system pressure: 50 psi
- Minimum pressure required: 14.7 psi
- Tubing diameter: 0.66″ OD; 0.56″ ID; 0.050″ wall
- Coil length: 100′, 250′, 1,000′
- Recommended minimum filtration: 120 mesh

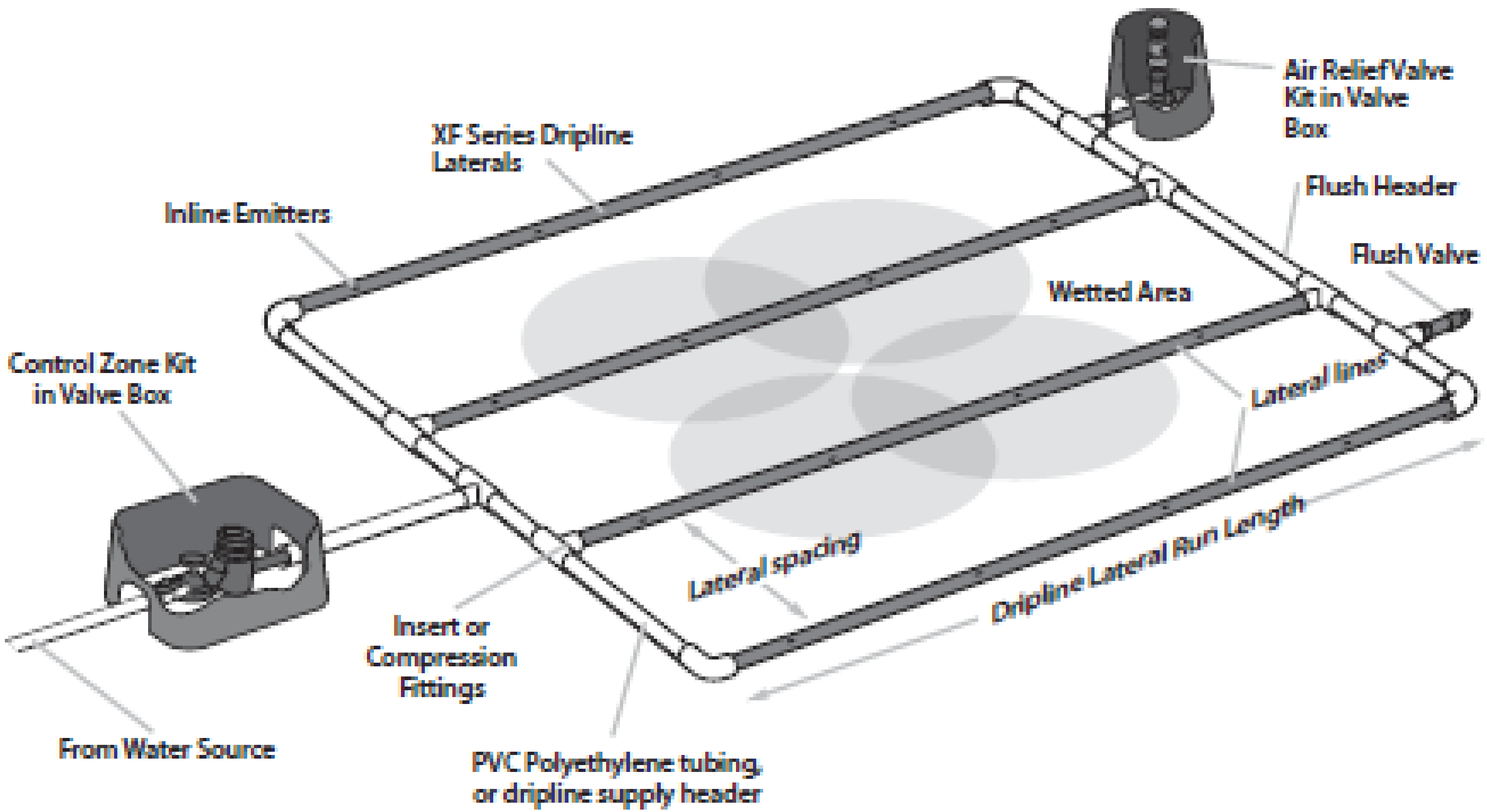
Toro Example: DL2000 Series

5/8" (.0620" ID X 0.710" OD			Inlet Pressure VS Maximum Length of Run In Feet			
Part No.	Flow Rate (GPH)	Emitter Spacing	15 psi	25 psi	30 psi	40 psi
RGP-212	.53	12"	250'	360'	400'	460'
RGP-218	.53	18"	350'	515'	565'	650'
RGP-412	1.0	12"	160'	240'	260'	300'
RGP-418	1.0	18"	240'	340'	375'	430'

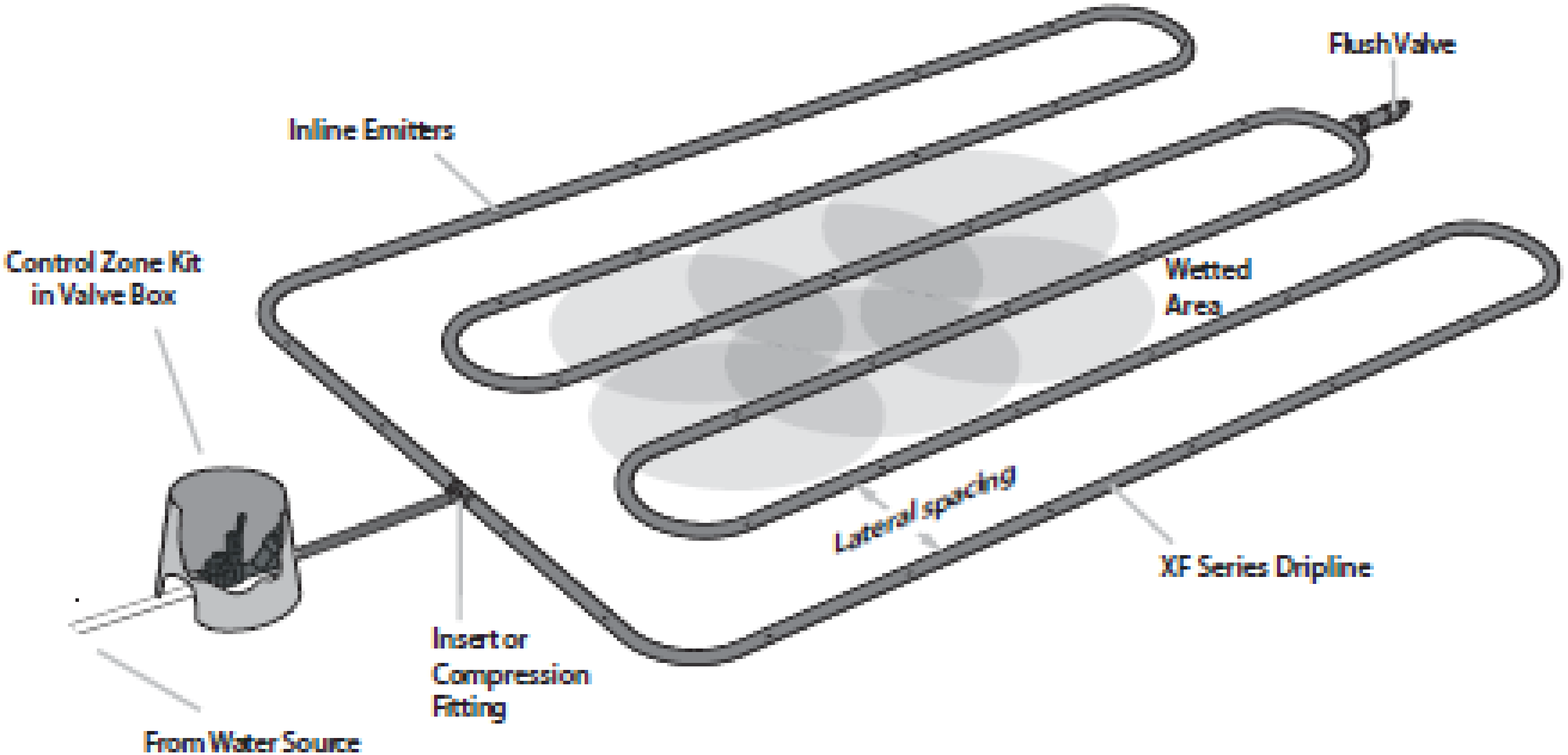
Performance Table	
Flow Rate	.53/1.06 GPH
Coefficient of Variation (Cv)	≤ 5%
Flow Exponent (x)	0.05
Inside Diameter	0.620"
Outside Diameter	0.710"
Wall	0.045"
Operating pressure (P)	15–60 psi
Minimum filtration requirement	120 Mesh
Hazen-Williams C factor	140
Barb loss factor (Kd)	.98

Drip Layout Options

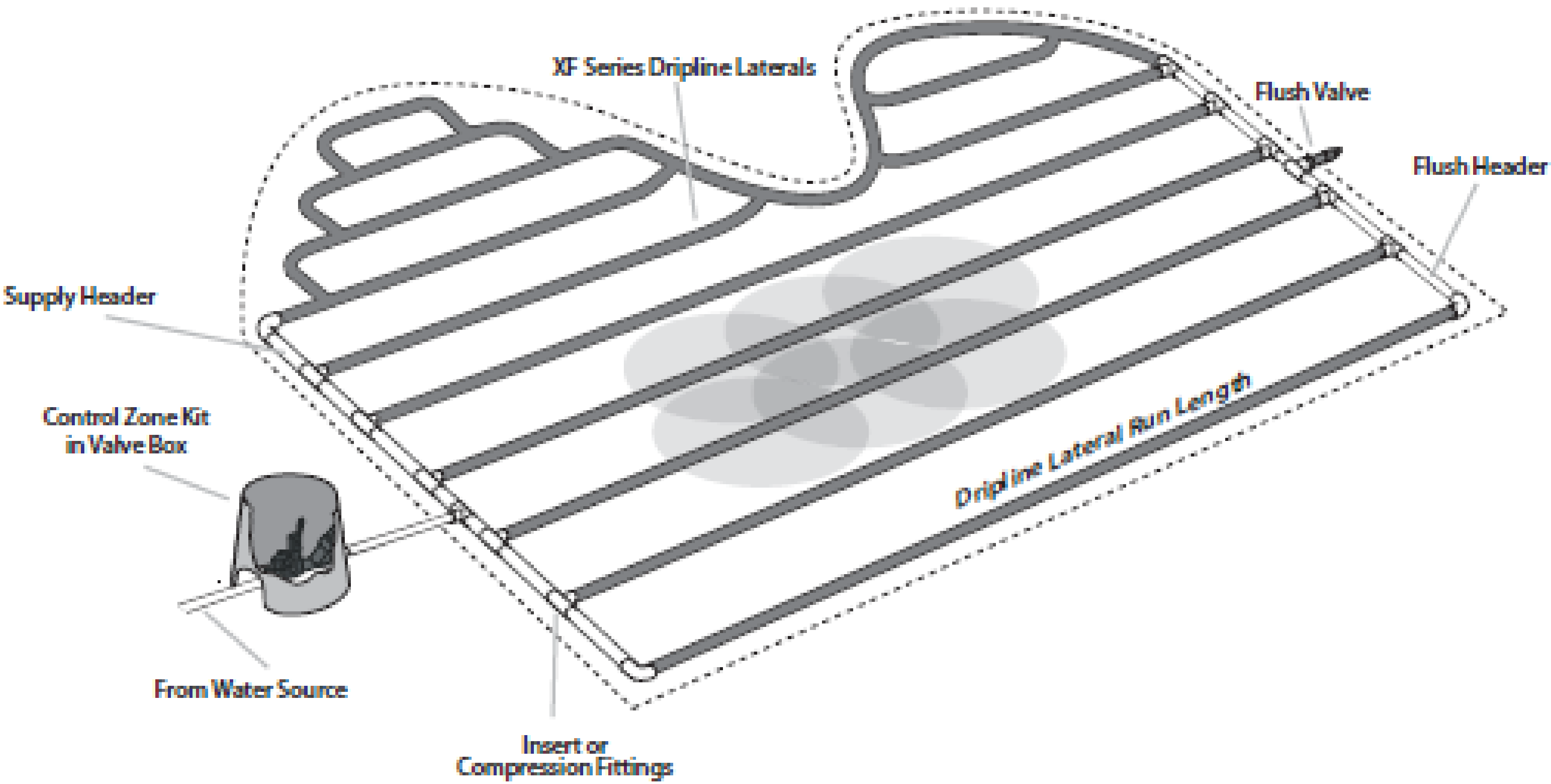
Manifold - End Feed Layout



“Quick” Layout



Curved (Edge) Layout



Designing Drip Irrigation Systems

The 7 Step Approach

Step 1

Calculate Peak Water Requirement

What are we irrigating?

Calculating Plant Water Requirements

- WR = ETo x Kc
  - Where:
    - ETo = Evapotranspiration, Peak Month
    - Kc = Plant Coefficient
    - WR = Plant Water Requirement

Calculating Peak Water Requirements

- Use Reference Evapotranspiration (ETo)
  - Defined as the plant water requirement of a cool season grass growing 4” tall under well watered conditions
  - Can be calculated using weather data
    - Temperature, Relative Humidity, Solar Radiation & Wind Speed
    - Methods with use solar radiation are the most accurate

Calculating Peak Water Requirements

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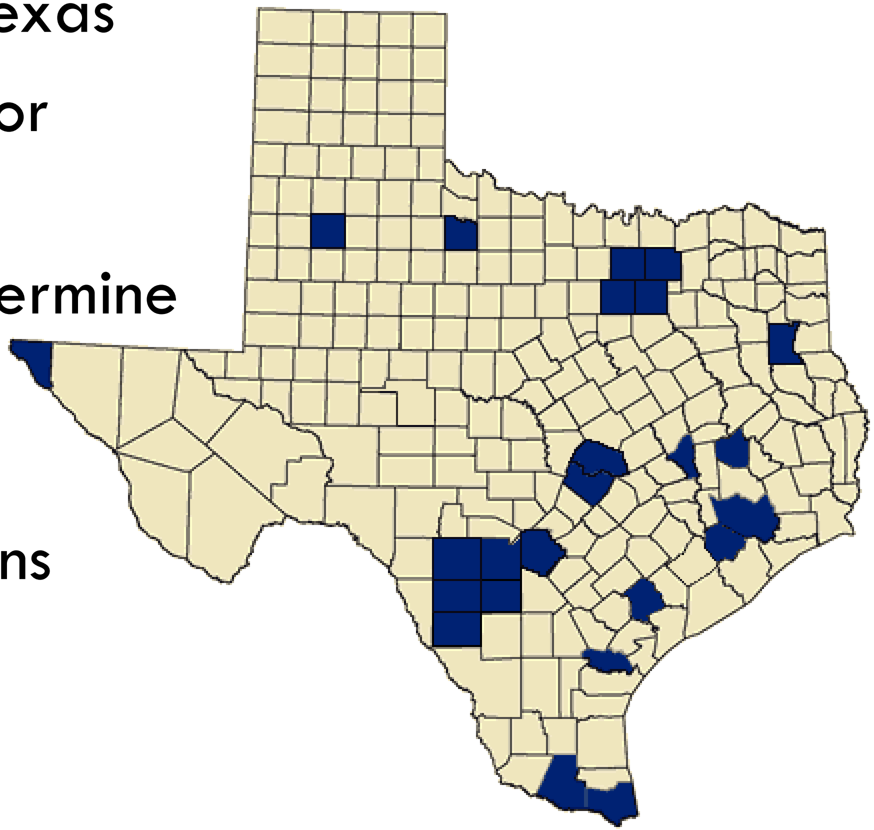
  - Can be calculated using weather data
    - Temperature, Relative Humidity, Solar Radiation & Wind Speed
    - Methods with use solar radiation are the most accurate

Evapotranspiration Sources

- TexasET Network
  - http://TexasET.tamu.edu
  - 34 Weather Stations in Texas
  - Contains historical data for 19 Cities in Texas
  - Online Calculators to determine irrigation runtimes
  - Can Sign Up or email irrigation recommendations



TexasET Network

- Historical ET Data available

Average Monthly ETo (PET) (inches/month)													
City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Abilene	2.08	2.57	4.14	5.48	6.47	7.65	8.36	7.46	5.48	4.21	2.67	2.08	**58.65**
Amarillo	1.84	2.27	3.73	5.06	5.89	7.51	8.08	7.29	5.61	4.05	2.4	1.78	**55.51**
Austin	2.27	2.72	4.34	5.27	6.39	7.15	7.22	7.25	5.57	4.38	2.74	2.21	**57.51**
Brownsville	2.65	3.03	4.48	5.17	6.03	6.32	6.68	6.65	5.21	4.34	3.01	2.59	**56.16**
College Station	2.2	2.71	4.22	5.2	6.25	6.89	7.1	6.85	5.6	4.3	2.8	2.2	**56.32**
Corpus Christi	2.42	2.95	4.28	5.17	5.95	6.43	6.68	6.65	5.21	4.34	3.01	2.59	**55.68**
Dallas/Ft. Worth	2.0	2.46	3.96	5.14	6.21	7.06	7.40	7.25	5.49	4.19	2.59	2.10	**55.85**

Plant Coefficients

- Warm Season Turf = 0.6
- Cool Season Turf = 0.8
- Sports Turf = 0.8
- Frequent Water Plants = 0.8
  - Flowers
- Occasional Water Plants = 0.5
  - Groundcover, tender vines, small shrubs
- Natural Rainfall Plants = 0.3
  - Large shrubs, Non Fruit Trees

Example Problem: Step 1

- Design a drip irrigation system for a St Augustine Grass growing in Austin
- WR = Eto xKc
  - ETo = Peak ETo For Austin 7.25 inches (August)
  - Kc = 0.6

  - WR = 7.25 inches x 0.6
  - WR = 4.35 inches, Peak Use in August

Example Problem: Step 1

- Peak Water Use = 4.35 inches per month
- Irrigation is scheduled on a weekly basis
- When designing a system you want to be able to deliver daily peak use within 24 hours
  - 4.35 inches peak month = .14 inches per day

Simplified Method

Plant Type	Typical Peak Daily Water Requirement (Texas)
Warm Season Turf	.17 inches
Cool Season Turf	.23 inches
Annual Flowers	.23 inches
Perennial Flowers, Groundcovers, Tender Woody Shrubs & Vines	.15 inches
Tough Woody Shrubs, Vines, Trees (non-fruit bearing)	.10 inches

Step 2

Choose a Product

Choosing a Product

- Choosing a product from one of the major manufacturers is highly recommended
- Irrigators typically have a particular brand they prefer to work with in most cases
- Can use manufacturers performance data such as Coefficient of Variation (Cv) to choose quality products

Choosing a Product

- Products such as "soaker hoses" typically don't publish or show Cv data
  - Soaker hoses are typically very inconsistent in their application of water for managing plant water usage
  - Cv values closest to Zero perform best

Example Problem: Step 2

- For Example Purposes lets use Rainbird Drip Product 12" Spacing, .6 GPH Flow

Inlet Pressure psi	XF Dripline Maximum Lateral Lengths (Feet)					
	12" Spacing		18" Spacing		24" Spacing	
	Nominal Flow (GPH)		Nominal Flow (GPH)		Nominal Flow (GPH)	
	0.6	0.9	0.6	0.9	0.6	0.9
15	255	194	357	273	448	343
20	291	220	408	313	514	394
30	350	266	494	378	622	478
40	396	302	560	428	705	541
50	434	333	614	470	775	594

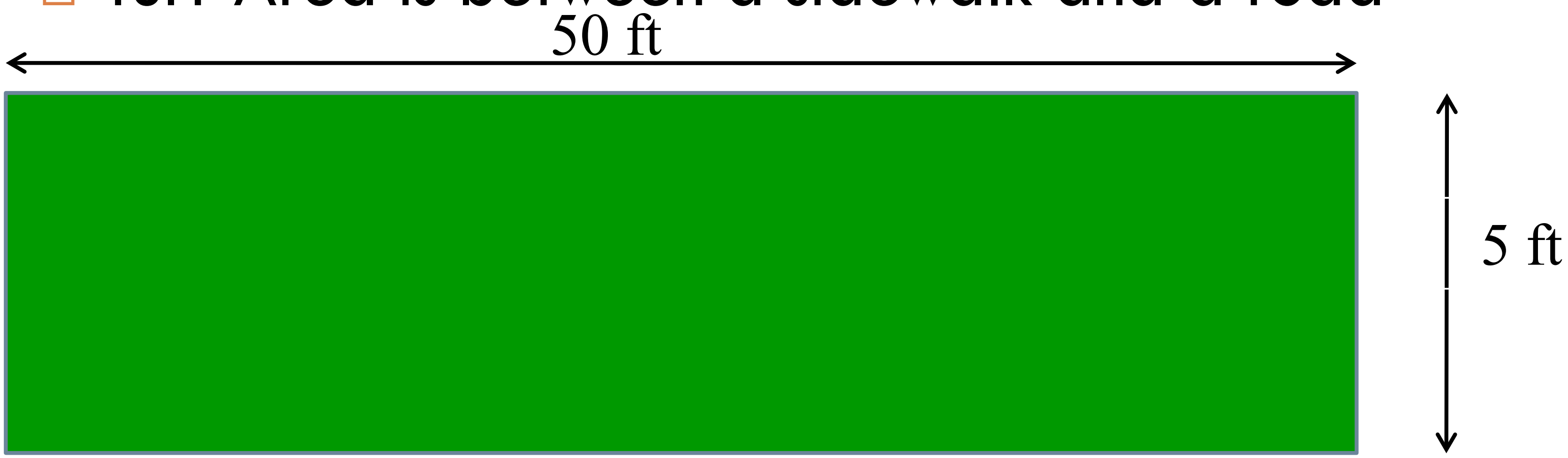
Step 3

Calculate the amount of product needed.

Length of tubing or number of emitters

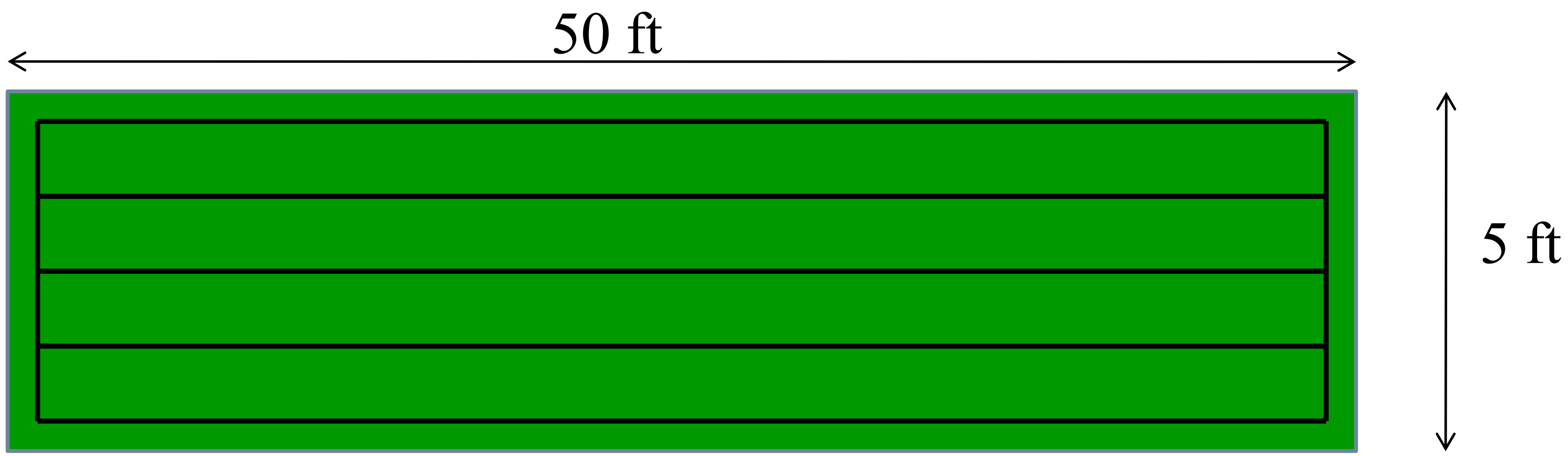
Step 3: Calculating the Amount of Product

- Turf Area is between a sidewalk and a road



- Product can be installed either in a "snaked" pattern or in a manifold
- Manifold systems are preferred, creates a looped system

Step 3: Product Layout



- Using a 12” product……come 6” off the edge
  - 4” By State Rule Minimum
- Total Product = 5 lines x 49ft + 2 lines x 4ft
- Total Product = 253 ft

Example Drip Grid Layout

Step 4

- Calculate the total flow of the design

Step 4: Calculate Total Flow

XF-SDI Dripline Flow (per 100 feet)				
Emitter Spacing	0.6 GPH Emitter		0.9 GPH Emitter	
12″	61.0 GPH	1.02 GPM	92.0 GPH	1.53 GPM
18″	41.0 GPH	0.68 GPM	61.0 GPH	1.02 GPM
24″	31.0 GPH	0.51 GPM	46.0 GPH	0.77 GPM

- 253ft x61 GPH/100ft = 154.33 GPH

  or
- 253ft x 1.02 GPM/100ft = 2.58 GPM

Velocity Limit Pipe Sizing
Maximum PVC Mainline Flow Rates*

Pipe Size and Type	Maximum Flow Rate At 5 ft/s
1/2" Schedule 40 PVC	4.7 gpm
3/4" Schedule 40 PVC	8.3 gpm
1" Schedule 40 PVC	13.5 gpm
1-1/4" Schedule 40 PVC	23.4 gpm
1-1/2" Schedule 40 PVC	31.8 gpm
2" Class 315 PVC	50.2 gpm
2-1/2" Class 315 PVC	73.5 gpm
3" Class 315 PVC	109 gpm

•If other pipe types are used, maximum flow rates determined by appropriate velocity for pipe type.

Step 5

Spec out additional drip system components from manufacturers literature

Step 5: Design Components

- What is the pressure requirement? Regulator?
  - 8.5-60PSI
- Are multiple stations/zones required?
  - No
- What size filter is needed?
  - 120 Mesh filter

Inlet Pressure psi	XF Dripline Maximum Lateral Lengths (Feet) 12" Spacing Nominal Flow (GPH) 0.6	12" Spacing 0.9	18" Spacing Nominal Flow (GPH) 0.6	18" Spacing 0.9	24" Spacing Nominal Flow (GPH) 0.6	24" Spacing 0.9
15	255	194	357	273	448	343
20	291	220	408	313	514	394
30	350	266	494	378	622	478
40	396	302	560	428	705	541
50	434	333	614	470	775	594

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

Step 6

Calculate Precipitation Rate

Step 6: Precipitation Rate

$$PR = \frac{96.25 \times GPM}{A}$$

PR – Station Precipitation Rate, in/hr

96.25 – Constant Converts GPM to inches per hour

GPM – Total Flow Rate through the station

A – Area of Coverage, ft^2

Precipitation Rate

$$PR = \frac{231.1 \times \text{Dripper Flow Rate}}{\text{Dripline Row Spacing} \times \text{Dripper Spacing}}$$

- PR = Station Precipitation Rate, in/hr
- 231.1 = Constant Converts GPH to in/hr
- Dripper Flow Rate, GPH
- Dripline Row Spacing, inches
- Dripper Spacing, inches

Example Problem

$$PR = \frac{96.25 \text{ x GPM}}{\text{Area}}$$

- GPM = Total Flow = 2.58 GPM
- Area = Length x Width = 50ft x 5 ft = 250 ft^2

$$PR = \frac{96.25 \text{ x } 2.58\text{GPM}}{250 \text{ ft}^2}$$

PR = .99 inches / hr

Step 7

Will the design work?

Step 7: Will design work?

- Can Precipitation Rate meet peak demand?
- Peak Demand Water Req. = .14 inches per day
- PR = .99 inches per hour

$$\text{Runtime} = \frac{\text{Water Requirement}}{\text{Precipitation Rate}}$$

$$\text{Runtime} = \frac{.14}{.99} = .14 \text{ hour} = 8.5 \text{ min} = 9 \text{ min}$$

What about shrubs?
And other bedding material?

Bed Irrigation: Grid or No Grid?

Goal in Drip Irrigation should be to only apply the water where its needed

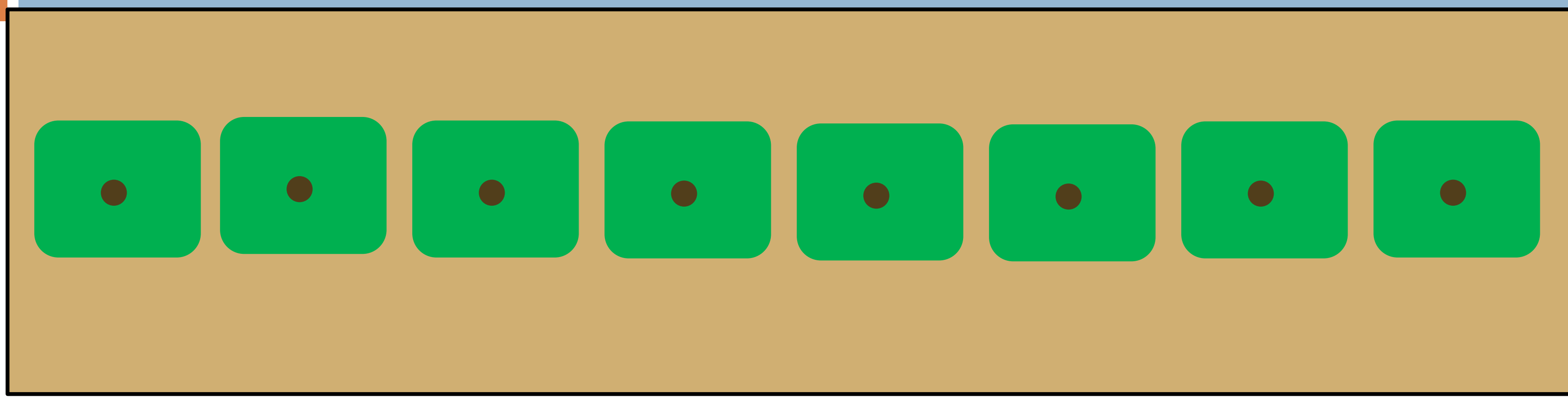
Often referred to as "Point Source" Irrigation

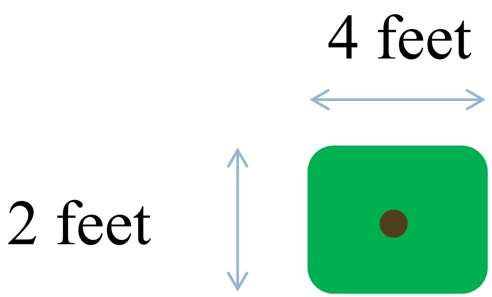
Designing Drip with Online Emitters (Shrubs)

Designing Drip For Shrubs Using Online Emitters

- Using Online emitters for shrubs allows for customization of the drip system to match the layout and spacing of the shrubs
- Always best to use professional judgment on what size emitter (flow) and the number of emitters per shrub plant (typically 1 or 2)

Example: Shrub Drip Design





8 Small Shrubs

Example: Shrub Drip Design

- Step 1
  - What are we irrigating?
    - Small Shrubs
  - What is the peak water requirement?
    - Typical Water requirement for (small) tender woody shrubs = .15 inches per day

Plant Type	Typical Peak Daily Water Requirement (Texas)
Warm Season Turf	.17 inches
Cool Season Turf	.23 inches
Annual Flowers	.23 inches
Perennial Flowers, Groundcovers, Tender Woody Shrubs & Vines	.15 inches
Tough Woody Shrubs, Vines, Trees (non-fruit bearing)	.10 inches

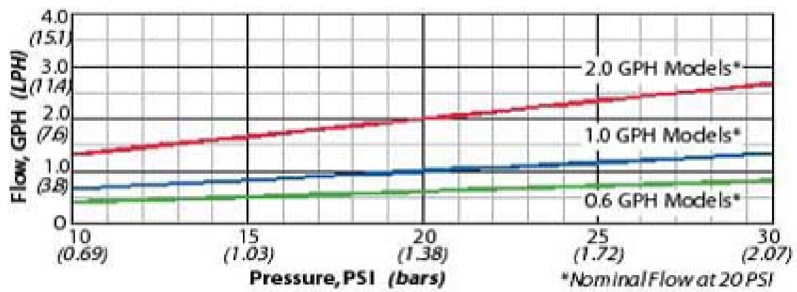
Example: Shrub Drip Design

- Step 2 Pick A Product……….1 GPH Emitter

NonStop Drip Emitters

All NonStop Drip Emitters nominal flow rates at 20 PSI *(1.38 bars)*

Nominal Performance



Emitter Nominal Flow	Pressure (PSI)				
	10	15	20	25	30
0.6	0.4	0.5	0.6	0.7	0.8
1.0	0.7	0.8	1.0	1.2	1.3
2.0	1.3	1.7	2.0	2.3	2.7

Emitter flows in GPH, nominal at 20 PSI

Notes:
Manufacturer�s variation,Cv: <= 0.05
30-mesh filtration and 15 PSI emitter operating pressure are the recommended minimums for a NonStop emitter system.

"SB" Series

Single barb outlet. 0.250" and 0.175" barbs on opposite ends; either can be used as inlet.

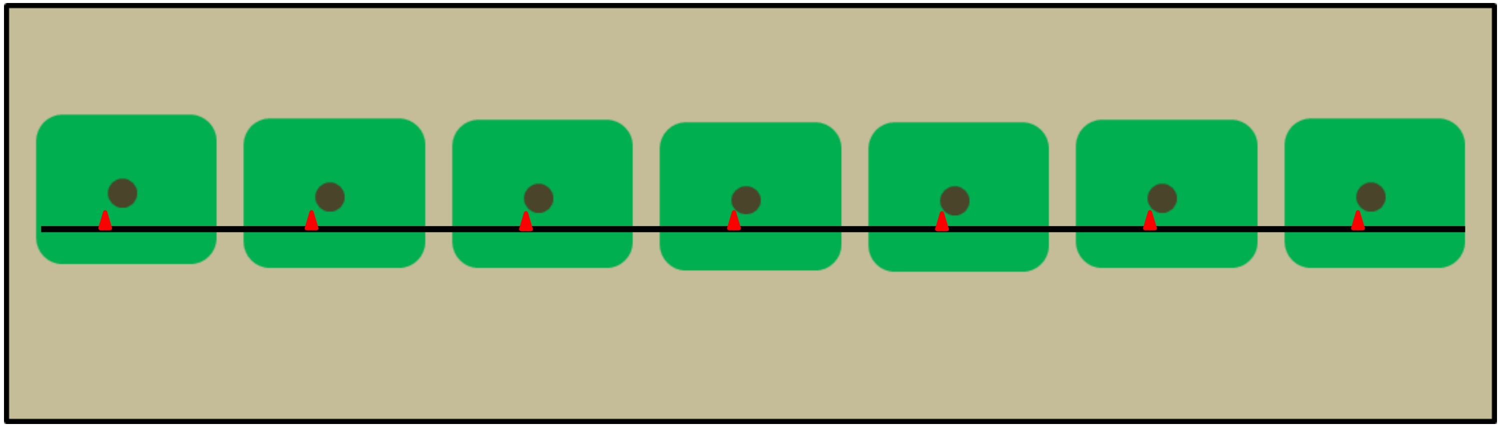
- SB-06 *0.6 GPH (2.3 LPH)* (Green Insert)*
- SB-10 *1.0 GPH (3.8 LPH)* (Blue Insert)*
- SB-20 *2.0 GPH (7.6 LPH)* (Red Insert)*

**Nominal flow at 20 PSI (1.38 bars)*

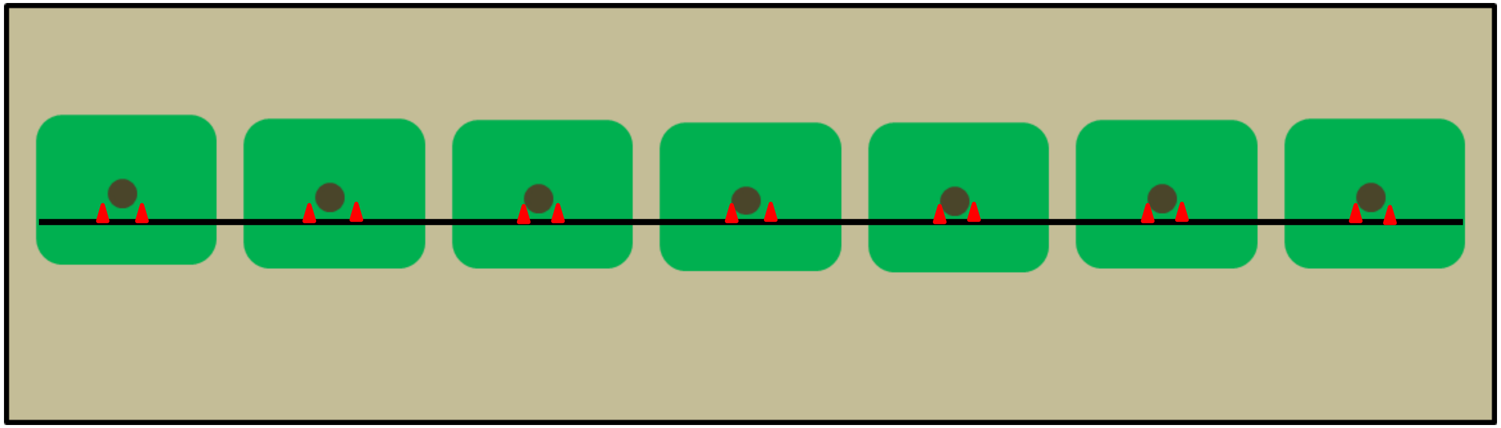
Example: Shrub Drip Design

- Step 3: How many emitters are needed?

<u>Option 1</u>
1
Emitter
per Plant

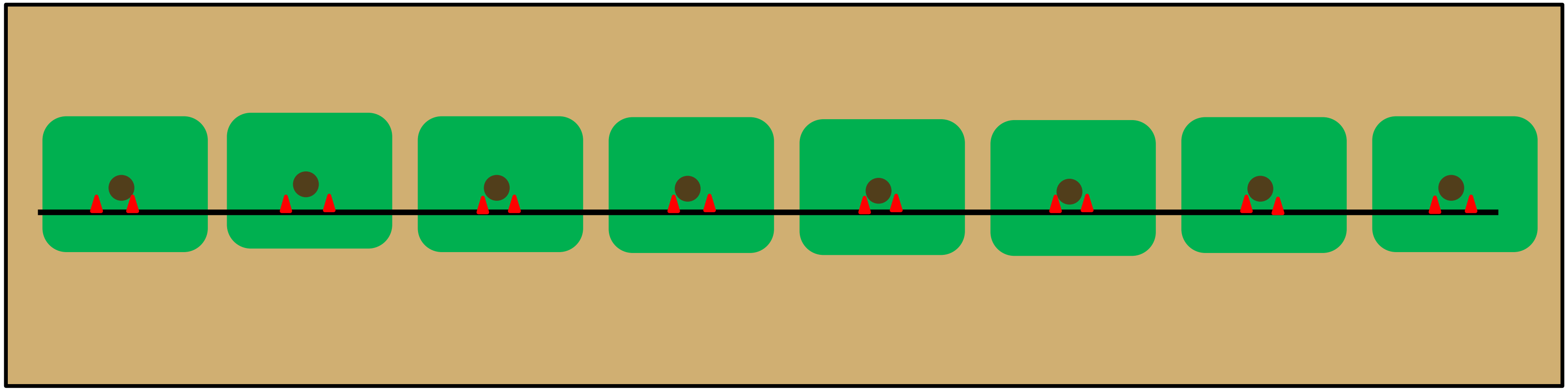


<u>Option 2</u>
2
Emitters
per Plant



Example: Shrub Drip Design

- Step 4: What is the total flow?



- 8 Plant x 2 Emitters per Plant = 16 Emitters
- 16 Emitters x 1 GPH per emitter = 16 GPH or .27 GPM

Example: Shrub Drip Design

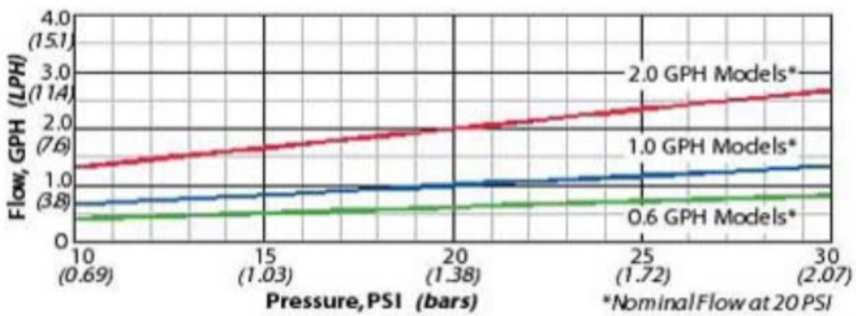
- Step 5 : Design Components
  - What is the pressure requirement?
    - 20 PSI
  - Are multiple stations/zones required?
    - No, only .27 GPM
  - What size filter is needed?
    - 30 Mesh minimum

Design Specs: Bowsmith Emitter

NonStop Drip Emitters

All NonStop Drip Emitters nominal flow rates at 20 PSI *(1.38 bars)*

Nominal Performance



Emitter Nominal Flow	Pressure (PSI)				
	10	15	20	25	30
0.6	0.4	0.5	0.6	0.7	0.8
1.0	0.7	0.8	1.0	1.2	1.3
2.0	1.3	1.7	2.0	2.3	2.7

Emitter flows in GPH, nominal at 20 PSI

Notes:
Manufacturer�s variation,Cv: <= 0.05
30-mesh filtration and 15 PSI emitter operating pressure are the recommended minimums for a NonStop emitter system.

"SB" Series

Single barb outlet. 0.250" and 0.175" barbs on opposite ends; either can be used as inlet.

- SB-06 *0.6 GPH (2.3 LPH)* (Green Insert)*
- SB-10 *1.0 GPH (3.8 LPH)* (Blue Insert)*
- SB-20 *2.0 GPH (7.6 LPH)* (Red Insert)*

**Nominal flow at 20 PSI (1.38 bars)*

Example: Shrub Drip Design

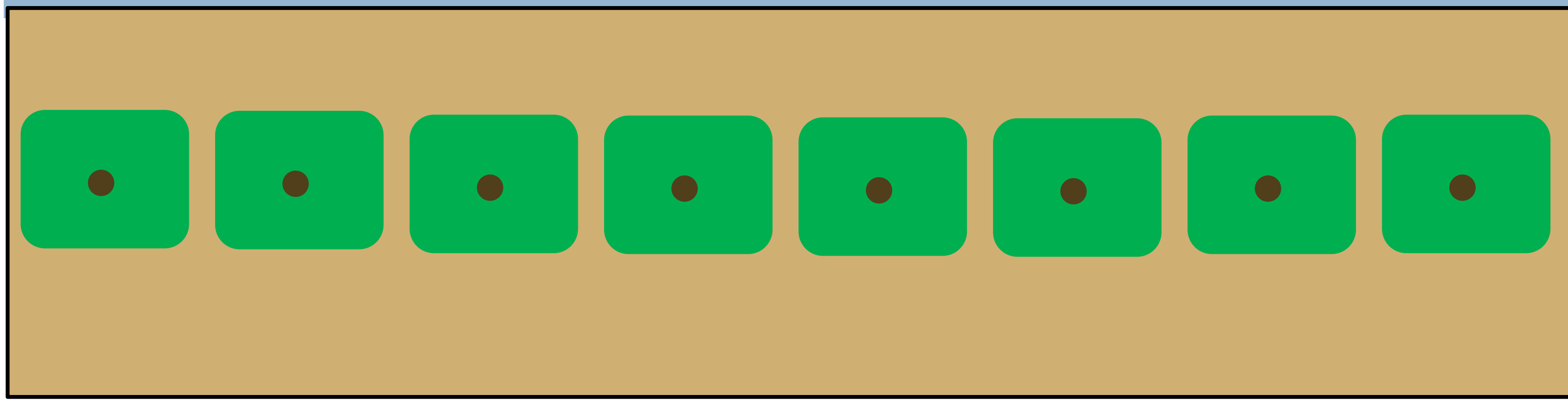
- Step 6: What is the Precipitation Rate

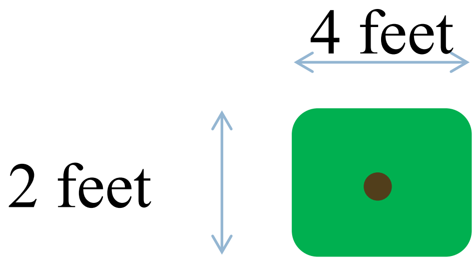
$$Precip.\,Rate = \frac{96.25\ x\ Total\ Flow\ (GPM)}{Area\ (ft^2)}$$

Total Flow = .27 GPM

Area = ???

Calculating Drip Area: Shrubs



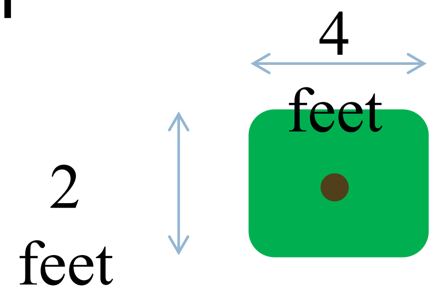


8 Small Shrubs

Area = Length x Width or Area = 3.14 x Radius^2

Calculating Drip Area: Shrubs

- Using Area = Length x Width



$4ft \times 2ft = 8ft^2$ per plant

Total Area = $8\ ft^2 \times 8$ plants = $64\ ft^2$

Example: Shrub Drip Design

- Step 6: What is the Precipitation Rate

$$Precip.Rate = \frac{96.25\ x\ Total\ Flow\ (GPM)}{Area\ (ft^2)}$$

Total Flow = .27 GPM

Area = 64 ft^2

Calculating Precipitation Rate

- $$Precip.Rate = \frac{96.25\ x\ .27GPM}{64\ ft^2}$$

Precipitation Rate = 0.41 Inches per Hour

Example: Shrub Drip Design

- Step 7: Will it work?
  - Can Precip. Rate meet peak demand (.15 Inches)?

$$Runtime = \frac{Peak\ Demand}{Precip.Rate} = \frac{.15\ inches}{.41\ \frac{in}{hr}}$$

Runtime = .37hours or 22 minutes

Adjusting Drip For Trees

Adjusting For Trees - Layout

Not Recommended

There is no additional water for the tree. The drip line is close to the trunk and the tree roots will probably push the buried drip line up to the surface.

Adjusting For Trees - Layout

Acceptable?

Although the tree and turfgrass are on the same zone, the buried drip line should be placed far enough away from the trunk so that tree roots do not push the drip line to the surface

Adjusting For Trees - Layout

Recommended?

The tree is on a separate zone and there is full separation between the tree and the turf grass

Micro Irrigation

Micro Irrigation

- Non drip tubing or tape with embedded emitters
- Focus' on:
  - Microspray devices
  - Point source emitters

Micro Spray Irrigation

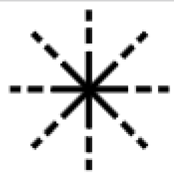
- Is a cross between spray irrigation and drip irrigation
- Low operating pressure
  - 15-30 PSI
- Low volume
  - 5-25 GPH

Micro Spray Irrigation

- Typically create a larger wetted area then drip tubing
  - 12-60 inches

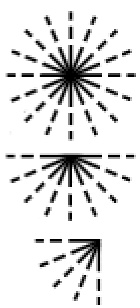
Micro Spray Irrigation - Literature

Solo-Drip Performance Data



	Pressure (PSI)	Flow (GPH)	Diameter of Throw (FT)
Adjustable to Maximum (approx 20 clicks)	15.0	0 - 11	0 - 1.5
	20.0	0 - 12.5	0 - 1.9
	30.0	0 -15.7	0 - 2.7

Trio-Spray Performance Data



Base Outlet Size

Pressure (PSI)	Flow (GPH)	SPRAY PATTERN: Diameter of Throw (FT) 360° X 18 Hole	SPRAY PATTERN: Radius of Throw (FT) 180°	SPRAY PATTERN: Radius of Throw (FT) 90°
10.0	0 - 16.7	0 - 17.3	0 - 7.2	0 - 5.7
15.0	0 - 20.3	0 - 18.9	0 - 8.2	0 - 7.0
20.0	0 - 23.4	0 - 20.4	0 - 9.1	0 - 8.1
25.0	0 - 26.1	0 - 21.8	0 - 9.9	0 - 9.0
30.0	0 - 28.6	0 - 23.1	0 - 10.6	0 - 9.9

Performance Data*

MODEL (nominal nozzle diameter)	Filtration Requirements mesh (Microns)	PRES (bar)	Flow (gph)	Dia (ft)	PRES (bar)	Flow (l/h)	Dia (m)
							340°
SP12-340 Blue (0.99mm/0.039")	150 (105)	15 20 25 30 35 40	10.1 11.6 12.9 14.1 15.3 16.3	18 19 20 21 21 22	1.0 1.5 2.0 2.5 3.0	38.0 45.0 53.0 58.0 65.0	5.6 6.0 6.4 6.6 6.8
SP16-340 Green (1.21mm/0.048")	120 (125)	15 20 25 30 35 40	15.1 17.4 19.4 21.2 22.8 24.2	20 21 22 23 23 24	1.0 1.5 2.0 2.5 3.0	57.0 67.0 80.2 86.3 95.0	6.0 6.6 7.0 7.2 7.2
SP24-340 Red (1.45mm/0.057")	100 (150)	15 20 25 30 30 40	20.9 24.1 26.9 29.3 31.4 33.3	21 23 24 24 25 25	1.0 1.5 2.0 2.5 3.0	79.0 95.0 110.0 118.0 130.0	6.4 7.0 7.4 7.6 7.8
SP30-340 Orange (1.73mm/0.068")	80 (180)	15 20 25 30 35 40	28.9 33.4 37.2 40.5 43.3 45.8	23 24 26 26 27 27	1.0 1.5 2.0 2.5 3.0	110.0 129.0 153.0 164.0 180.0	7.0 7.6 8.0 8.2 8.4

Micro Spray Irrigation - Literature

MODEL (nominal nozzle diameter)	PRES.	FLOW	A DIAMETER	B LENGTH	B WIDTH	C RADIUS	D DIAMETER	E DIAMETER	F DIAMETER	G LENGTH	G WIDTH
NOZZLE	psi	gph	ft	ft	ft	ft	ft	ft	ft	ft	ft
QN-05 Black 0.026"	10	3.7	8.5	8.0	7.5	4.0	8.0	3.0	10.0	9.0	6.0
	15	4.6	9.5	10.0	8.5	4.5	9.5	3.0	11.0	10.0	6.5
	20	5.2	10.5	11.0	9.0	5.0	11.0	3.0	12.0	11.0	7.0
	25	5.9	11.0	11.5	9.5	5.3	11.0	3.0	12.5	12.0	7.5
	30	6.5	11.5	12.0	10.0	5.5	11.0	3.0	13.0	13.0	8.0
QN-08 Orange 0.033"	10	5.6	13.0	10.0	7.5	4.5	9.5	3.0	12.5	12.0	7.0
	15	6.9	13.5	11.5	8.5	5.0	11.0	3.0	13.5	13.5	8.0
	20	8.0	14.0	12.5	9.5	5.5	12.5	3.0	14.0	15.0	9.0
	25	9.2	14.5	12.5	9.5	6.0	13.5	3.0	14.0	16.5	10.0
	30	10.0	15.0	13.0	10.0	6.5	14.5	3.0	14.5	18.0	10.5
QN-12 Blue 0.038"	10	7.3	17.0	11.0	9.5	4.5	11.0	3.0	14.5	15.0	8.0
	15	9.1	17.5	13.0	10.0	5.3	12.5	3.0	15.5	16.5	9.0
	20	10.6	18.0	14.5	10.5	6.0	13.5	3.0	16.0	18.0	9.5
	25	11.8	18.0	15.0	11.5	6.5	15.8	3.0	17.0	20.5	10.5
	30	13.2	18.0	15.5	12.0	7.0	18.0	3.0	17.5	23.0	11.0
QN-14 Violet 0.044"	10	9.7	19.0	13.0	10.0	5.0	12.0	3.0	16.5	15.5	8.5
	15	11.8	20.0	16.0	11.5	5.5	14.0	3.0	17.5	17.5	9.5
	20	13.7	20.5	17.0	12.0	6.0	15.5	3.0	18.5	19.5	10.0
	25	15.5	20.5	18.0	12.5	6.0	18.0	3.0	19.5	22.0	11.0
	30	17.2	21.0	19.0	13.0	7.0	20.5	3.0	20.5	24.0	11.5
QN-17 Green 0.048"	10	10.7	21.0	15.0	10.5	6.0	13.0	3.0	17.0	16.0	9.0
	15	13.3	22.0	15.0	12.0	6.0	15.0	3.0	18.5	18.5	10.0
	20	15.5	22.5	19.0	12.5	6.0	17.0	3.0	20.0	20.5	10.5
	25	17.4	23.0	20.0	13.0	6.5	20.0	3.0	21.5	23.0	11.0
	30	19.1	23.5	21.0	13.5	7.0	23.0	3.0	23.0	25.0	12.0
QN-24 Red 0.057"	10	14.2	23.0	16.0	11.5	6.5	15.0	3.0	18.0	18.5	11.0
	15	17.3	25.5	18.0	12.5	7.0	17.0	3.0	20.0	20.5	12.0
	20	20.1	28.0	19.5	13.0	7.5	19.0	3.0	21.5	22.0	13.0
	25	22.4	28.0	21.0	13.5	7.5	24.0	3.0	23.5	24.0	13.5
	30	26.0	28.0	22.0	14.0	7.5	25.0	3.0	25.0	25.5	14.0
QN-33 White 0.068"	10	17.2	25.0	18.0	11.0	7.5	17.5	3.0	19.0	21.0	13.0
	15	21.0	26.0	21.0	13.0	8.3	19.2	3.0	21.0	22.5	14.0
	20	25.2	27.0	23.0	14.5	9.0	21.0	3.0	23.0	23.5	14.5
	25	27.9	28.0	24.0	15.0	9.4	23.0	3.0	25.0	25.0	15.5
	30	30.6	28.0	25.0	15.5	9.5	25.0	3.0	27.0	26.0	16.0

Recommended Filtration (Mesh, Microns): QN-05 (200, 74), QN-08 (170, 93), QN-12 (150, 105), QN-14 (130, 118), QN-17 (120, 125), QN-24 (100, 150), QN-33 (80, 180)

Micro Irrigation

- Micro Irrigation often uses micro-tubing, referred to as “spaghetti hose” (about ¼” tubing) to connect water supply to various emitters.
- Allows flexibility in emitter placement throughout the landscape area

Micro Irrigation

Converting Sprinklers to Drip

- Manufacturers make "quick" conversion devices
- State regulations do not allow mixed sprinklers on the same valve
  - Non matched precipitation rates

Drip Conversion Kit-Micro

Drip Conversion Kit - Tubing

- Conversion kits usually replace and existing sprinkler with a drip adaptor
  - Example of Kit
    - Spray body contains filter and pressure regulator
    - Can also contain fittings for connection to drip tubing

Clogging Control

Chemigation

Chemigation

General term that includes:

- Fertigation
- Insectigation
- Fungigation
- Nematigation

Advantages of Chemigation

- Uniformity of application
- Precise application
- Economics
- Timeliness
- Reduced soil compaction and crop damage
- Operator safety

Disadvantages of Chemigation

- High management
- Additional equipment
- Must calculate injection rates and volumes

Chemigation and Regulations

- General Classes
  - Controlled Substances
    - Pesticides and Herbicides
  - Fertilizers and Nutrients
  - Drip Maintenance/Clogging Control Chemicals
    - Chlorine and Acids

Controlled Substances

- Pesticides and Herbicides
  - Highly regulated by the EPA and States (TCEQ)
  - Regulations cover labeling, mixing/injection, and equipment
  - Regulations designed to protect the environment, human health and water supplies

The US EPA's Label Improvement Program (LIP)

- Established in the 1980's
  - Fully implemented in 1988
- States were required to implement regulations at least as stringent as proposed by the EPA
- Labels must state whether product is approved to be applied through the irrigation system
- Application instructions are provided
- Requires use of specific safety equipment and devices designed to prevent accidental spills

Chlorine

- Injected to control biological clogging of lines and emitters
- Household bleach is often used in small systems (5.25% chlorine)
- 5 ppm solutions commonly used
- Higher concentrations (up to 100 ppm) if iron bacteria and/or organic matter are problems

Chlorine

- Chlorine concentration at the end of the drip line should be:
  - 1 to 2 ppm for occasional treatment
  - 0.5 to 1 ppm for continuous treatment
- Begin with a low concentration (5 ppm to 10 ppm) for one hour

Acid Injection

- Acid is injected to control mineral clogging of emitters
- Water with a high pH (>7.5) or

  "*moderate*" to "*hard water*" (>60 ppm Ca) more likely to cause problems

Acid Injection

- 98% sulfuric acid is commonly used in drip irrigation
- Citric acid or vinegar can be used in organic farming
- Titration can be used to determine concentration of acid need

(adding acid to a sample of the water to see how much is required to lower pH)

Acid Injection

- Experimentation is used in absence of titration
- Acid is injected until pH is lowered to 6.5 (measured at end of drip line)
- Higher concentrations are added if needed, lowering pH to as low as ~4
- Acid is corrosive – inject downsteam of filter if made of metal

Common Reasons for Drip Failure

Drip Mistakes

- Failure to calculate drip precipitation rates
  - Irrigate too much
    - Often assume really long runtimes are needed because it is drip
  - Don't irrigate enough

Drip Mistakes

- Soaker Hoses?
  - Poor Uniformity
  - No Performance Data

Drip in El Paso

Drip Mistakes – Failure to Maintain

- Drip Failure in a Parking Lot

Drip Failure – Drip Under New Sod

- Drip Running Too Long after new Sod Install

Drip Mistakes

- Don't know how to layout the product
  - How to layout product for trees?
    - Double loop works well, ensures plenty of water in establishing trees
    - Inner loop can be removed as the base grows

Drip Mistakes

- Don't know how to layout the product
  - Important to try to maintain consistency in spacing
  - Stake down product if necessary
  - Manifold and/or loop the system

Installing Drip With Mulch

- Will the drip be on top, inside or under the mulch?
- Moisture can build up in mulch……wood is absorbent
- Allow long enough runtimes for water to reach the soil and root zone
- Recommend installing drip first then covering with mulch, can allow for an opportunity to test coverage

Drip Mistakes

- Poor spacing selection based on soil type
  - Avoid wide spaced emitters and laterals in heavy soil types

Other Mistakes

- Exceeding Maximum Length of run
  - Avoid “Snaking” a product though a bedded area
  - Manifold or Loop product for increased performance
- No Filtration
- No Pressure Regulation
- Improper zoning
  - Irrigating different “hydro-zones” with one drip zone

Websites

- Irrigation Technology Center
  - http://itc.tamu.edu
- School of Irrigation
  - http://irrigation.tamu.edu
- TexasET Network
  - http://texaset.tamu.edu

Any Questions??