Irrigation Design & Materials

AMERICAN SOCIETY OF LANDSCAPE ARCHITECTS
Washington Chapter

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CBRE

Course Overview

1. Introduction & Water Use
2. Basic Hydraulics
3. Irrigation Materials Intro
4. Irrigation Design Walkthrough
5. Pipe Sizing & Worst Case Zone
6. Irrigation Controllers
7. Legend & Construction Details
8. Construction Phase

Course Overview

1. Design Project Overview
2. Pipe Sizing & Worst Case Zone
3. Irrigation Controllers
4. Legend & Construction Details
5. Construction Phase
6. Alternative Water & Rainwater Harvesting

Introduction

Landscape Architecture
& Irrigation Design

Water Use & Conservation

World Supply

- 97% of water on earth is in oceans
- 3% of water on earth is fresh water
- Less than 1% of the water on earth is readily available for human use

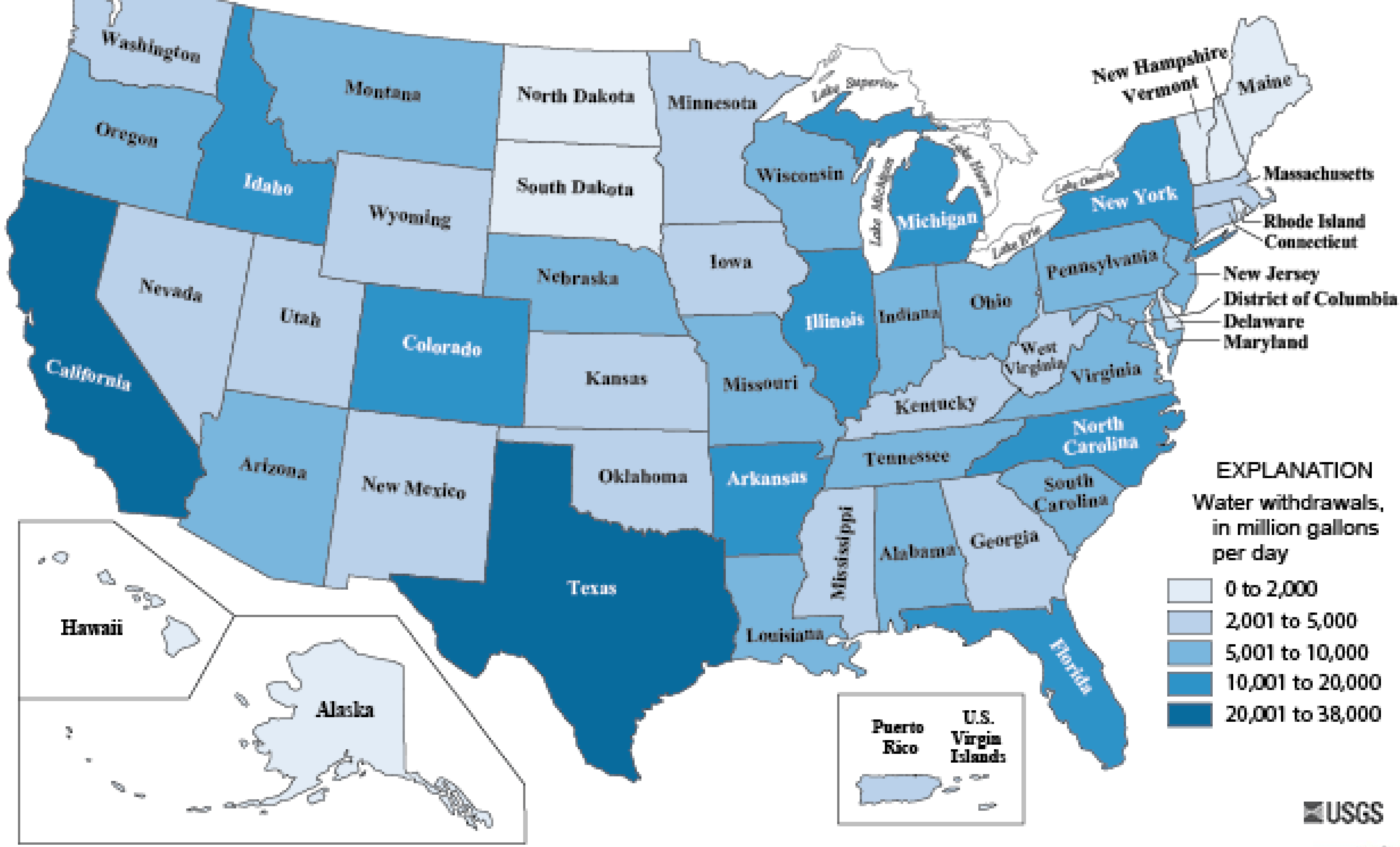
U.S. Supply

Shortages throughout U.S.

Climate change predicted to reduce supply

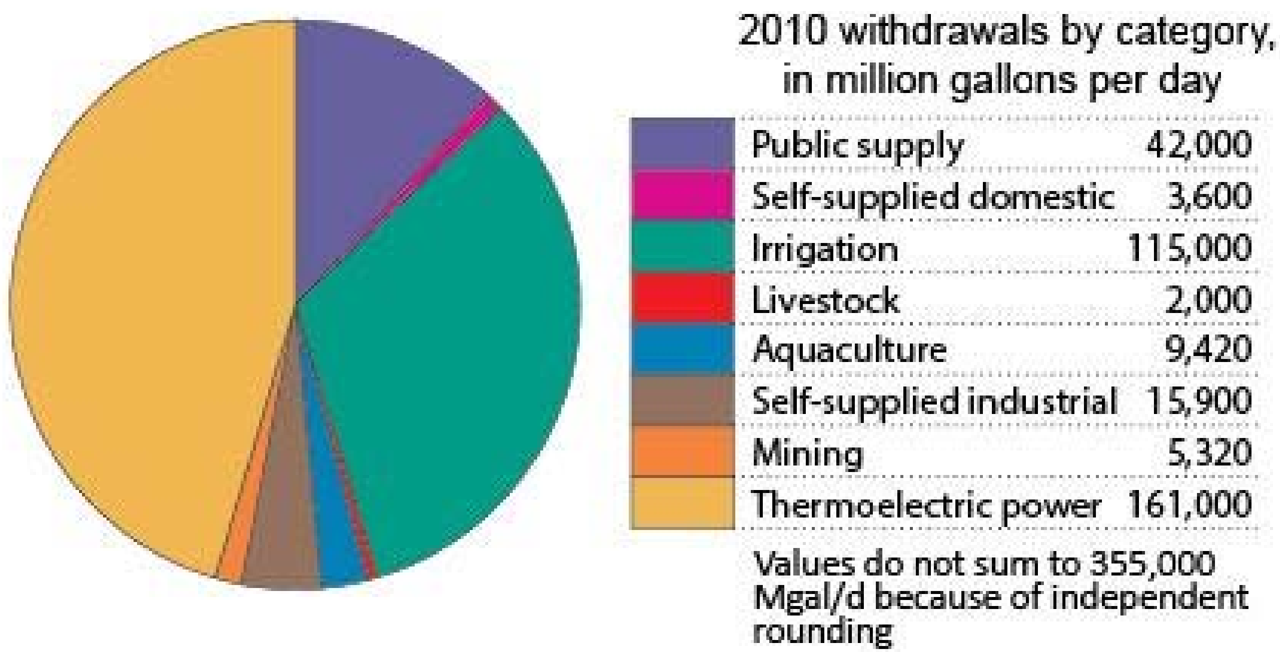
Price point of water

Total Water Use, 2010



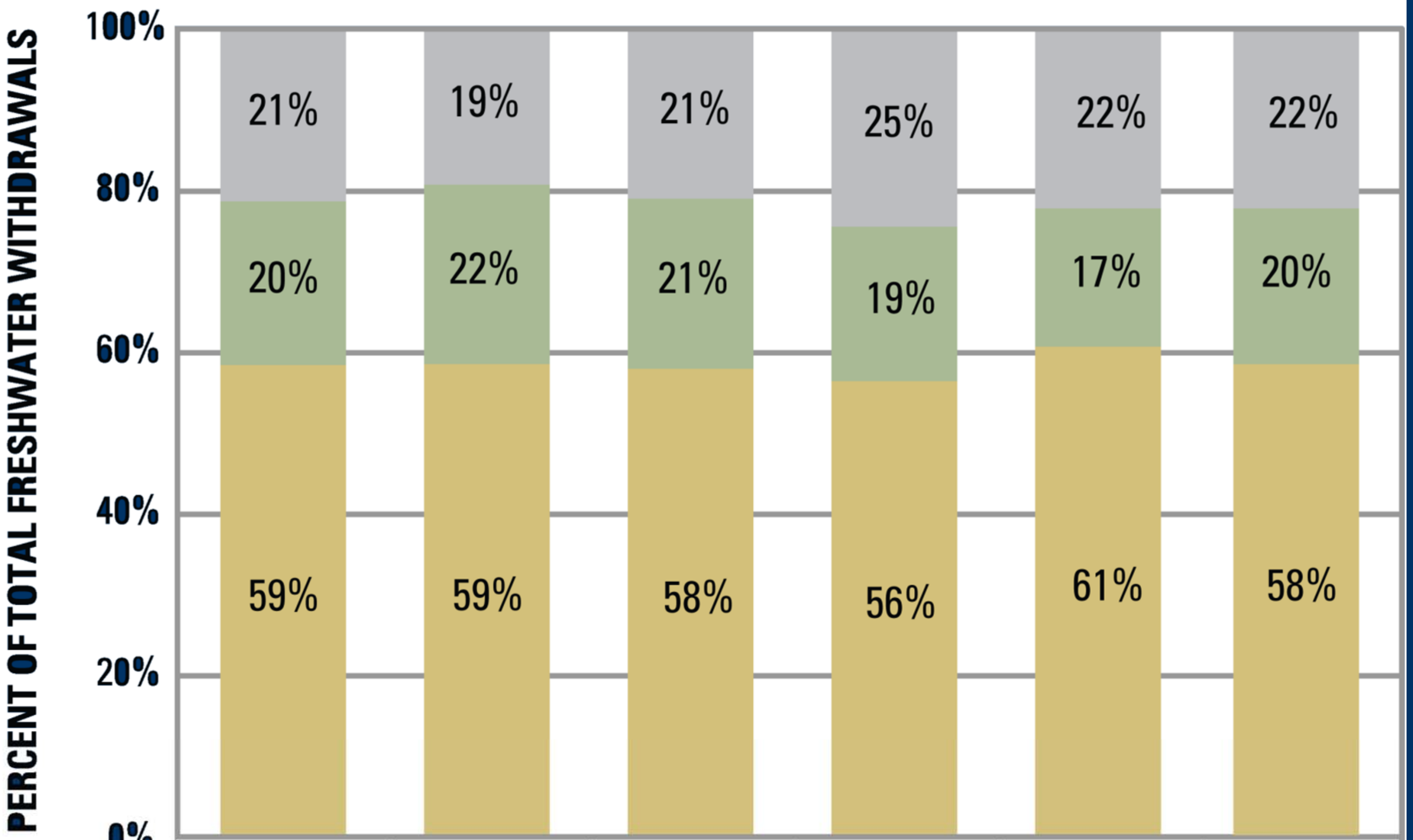
Total water withdrawals, top states, 2010 [percentages calculated from unrounded values]

State	Percentage of total withdrawals	Cumulative percentage of total withdrawals
California	11%	11%
Texas	7%	18%
Idaho	5%	23%
Florida	4%	27%
Illinois	4%	30%



Source: USGS

Washington Water Usage – Total Withdrawals



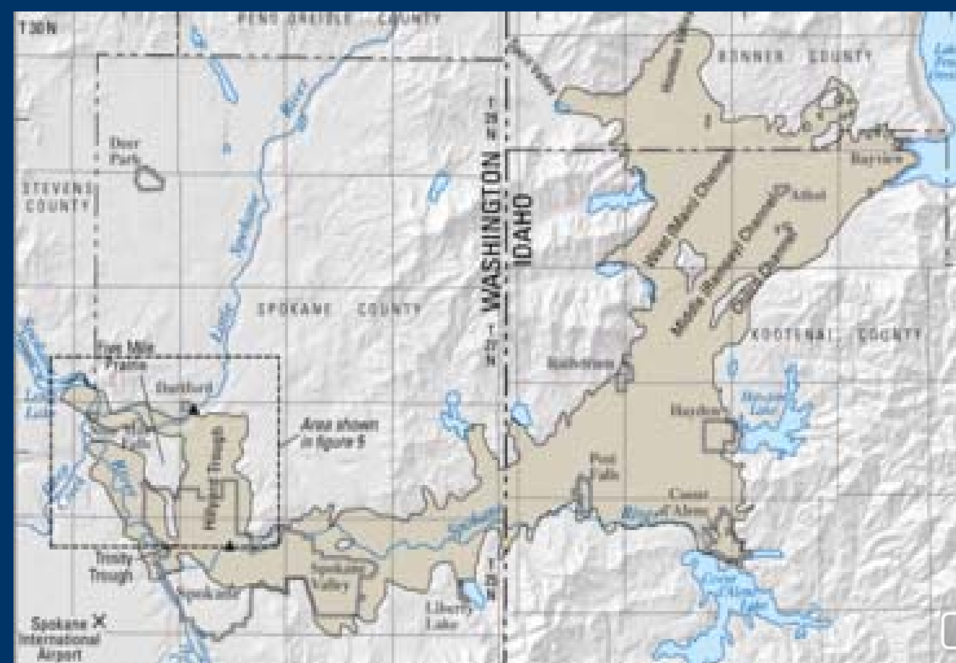
	1985	1990	1995	2000	2005	Totals
Other categories*	1,100	1,000	1,170	1,310	1,290	5,870
Public supply*	1,050	1,160	1,180	1,020	990	5,400
Crop irrigation*	3,030	3,060	3,250	3,000	3,500	15,840

*In million gallons per day

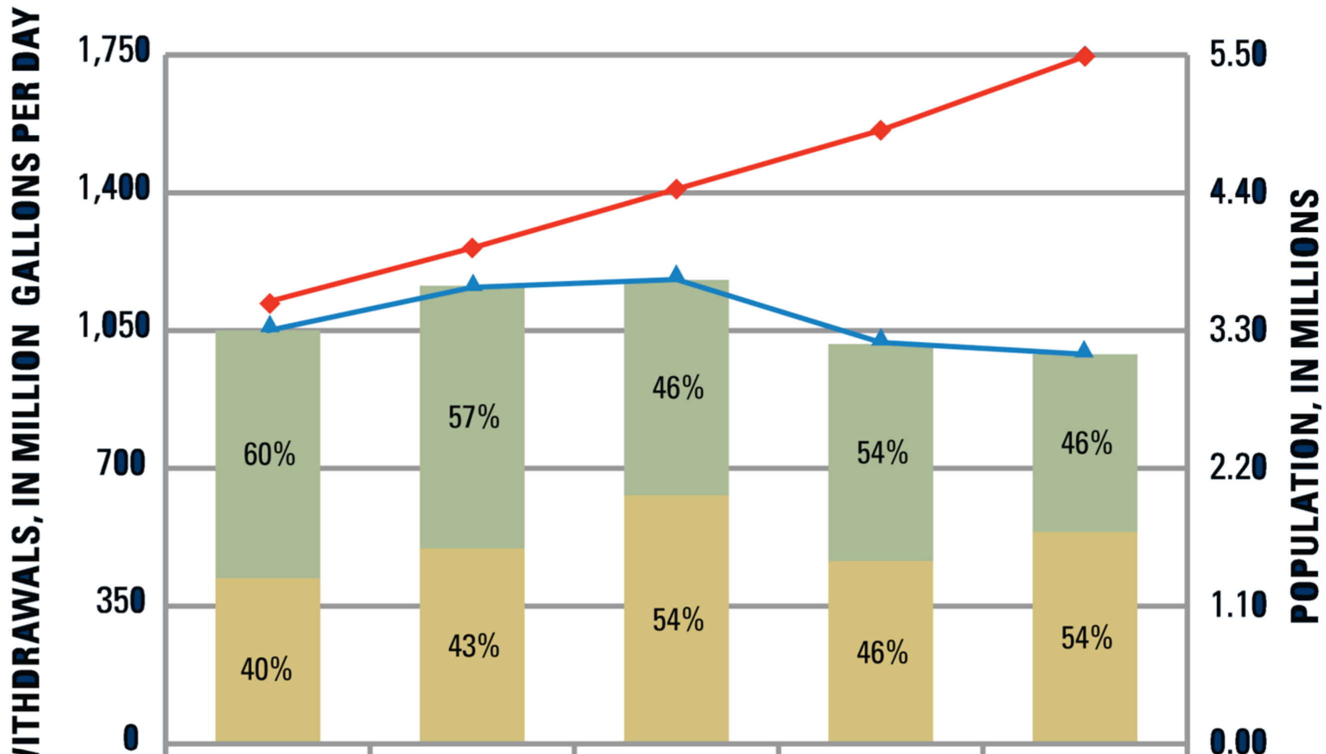
Source: USGS

WASHINGTON WATER SOURCES

Spada Reservoir, courtesy of City of Everett



Washington Water Usage – Public Supply

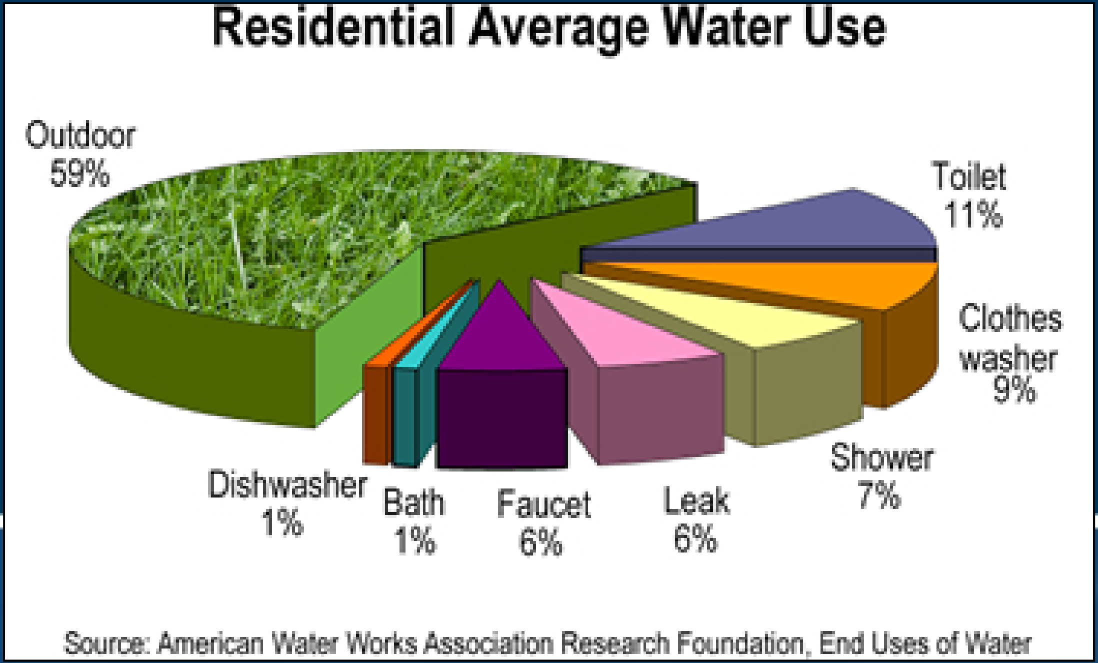


	1985	1990	1995	2000	2005
Surface water	630	667	548	552	451
Groundwater	421	497	631	464	539
Public supply water	1,050	1,160	1,180	1,020	990
Public supply population	3.53	3.96	4.43	4.90	5.49

Source: USGS

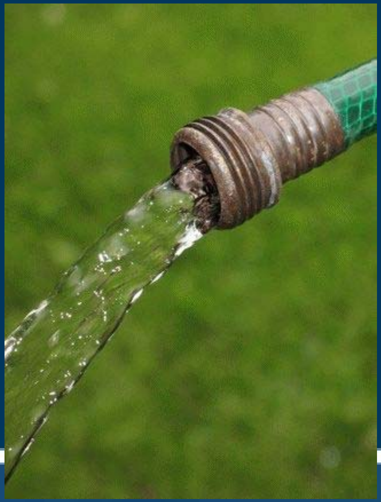
Landscape Water Use

- Residential demand in U.S. averages more than 26 billion gallons per day
- 59% is devoted to outdoor use (US average).
- Peak demand in hot summer months can be 1.5 – 3.0 times higher than average demand.



Lawn Water Use Facts

- 80-90% of outdoor use goes to watering lawns and plants
- U.S. lawn obsession has resulted in significant water consumption. - Las Vegas up to 70% of residential water use
- "America's biggest drinking problem isn't alcohol: It's lawn watering." Amy Vickers.



Basic Water Hydraulics

Pressure, Velocity, and Flow

Weight of Water

- Creates static pressure

Static Pressure

- Pressure of water at rest (not moving, system off)

Dynamic Pressure

- Pressure of water in motion (moving through system)

Basic Water Hydraulics

Pressure

- Force per unit area
- Psi or feet of head

Velocity

- Speed or rate of movement
- Feet per second

Flow

- Amount or discharge rate
- Gallons per minute or hour (gpm or gph)

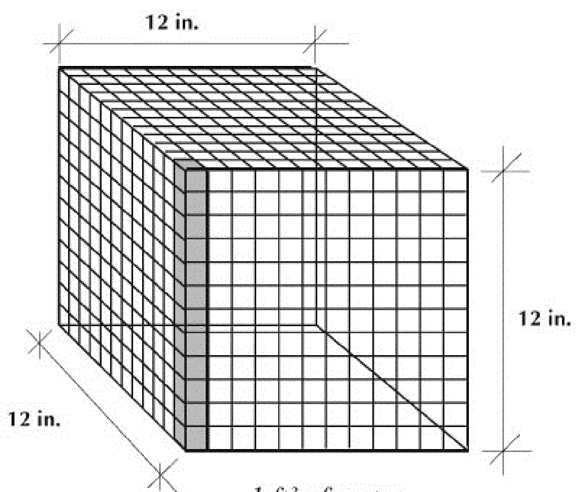
How pressure is created by the weight of water

What water weighs at 60° F:

- 1 cubic foot (ft.^{3}) or 1728 cubic inches (in.^{3}) of water = 62.37 lb.
- 1 cubic inch, (in.^{3}) of water = 0.0361 lbs.

Water creates pressure in landscape irrigation systems by the accumulated weight of the water.

In Fig. 1, we can see a container 1 ft. high and 1 ft. wide, holding 1 ft.^{3} of water, would create a column of water 1 ft. high over every square inch on the bottom of the container.



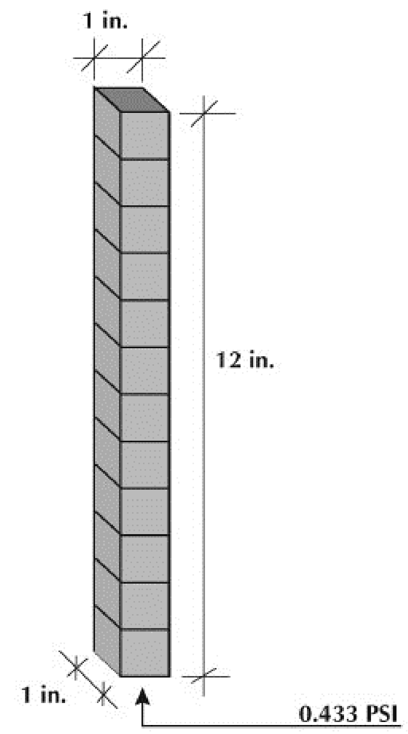
1 ft³ of water
Fig. 1

If we look at just one of those columns, Fig. 2, we can calculate the weight of water pressing on the bottom of the column in pounds per square inch (PSI).

Weight of Water

1 cubic ft of water = 62.37 lbs

weight creates pressure



Important Facts

This gives us some important facts to remember.
Memorize these facts:

- A column of water 1 ft. high = 1 foot of head = 0.433 PSI.
- 1.0 PSI equals the pressure created by a column of water 2.31 ft. high, or 1 PSI = 2.31 ft. of head (ft./head).
- A column of water 1 ft. high creates 0.433 PSI at the bottom, or 1 ft./head = 0.433 PSI.

Shape or size of container does not effect pressure

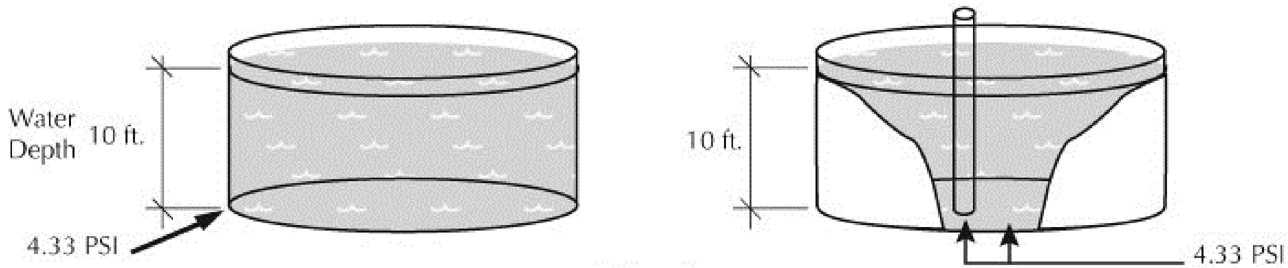


Fig. 4

What does this mean in irrigation system design?

When designing landscape irrigation systems, **for every 1 ft. of elevation change there will be a corresponding change of pressure of 0.433 PSI.**

Basic Water Hydraulics

Static Pressure is created by elevation change or by a pump

200ft x 0.433 psi = 86.6 psi

86.6 psi x 2.31 = 200 ft of head

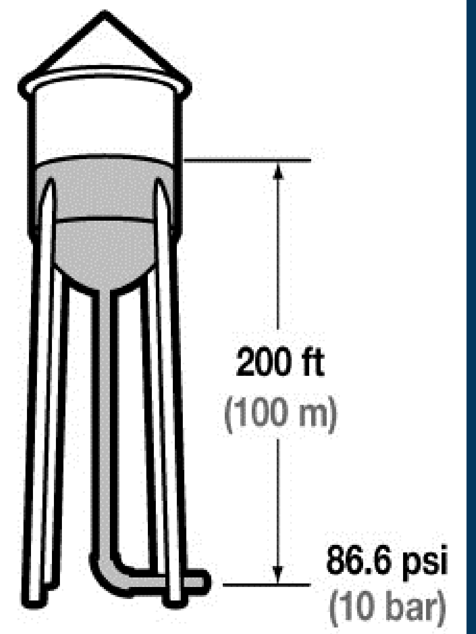
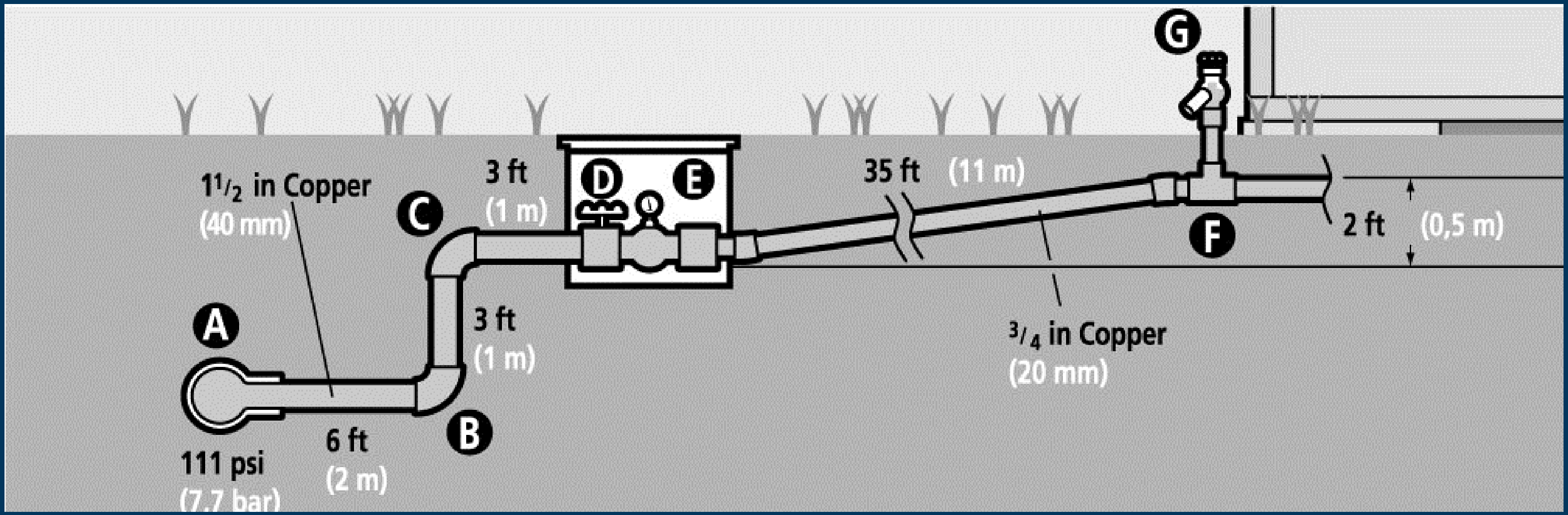


Figure 2: Water tower – 200 ft (100 m)

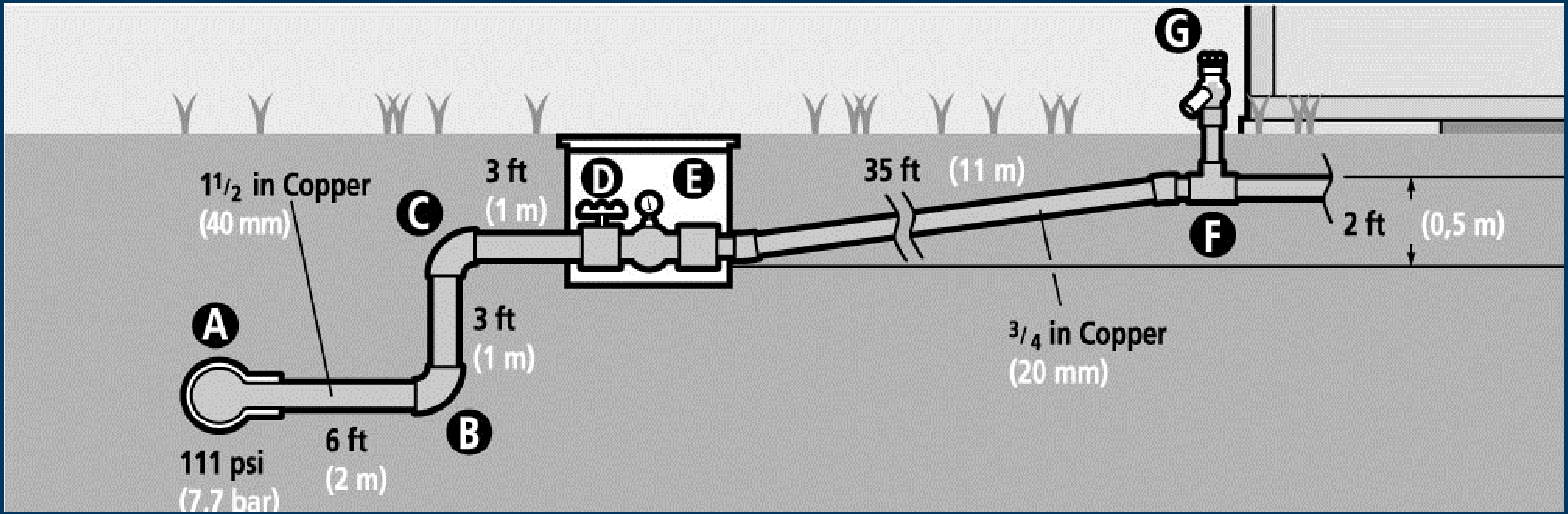
Static Pressure Exercise



A (city line) = 111 psi
B = 111 psi
C = ? psi
D = ? psi

E (meter) = 111 psi
F = ? psi
G = ? psi

Static Pressure Exercise



A (city line) = 111 psi
B = 111 psi
C = 109.7 psi
D = 109.7 psi

E (meter) = 109.7 psi
F = 108.8 psi
G = 108.36 psi

Dynamic Pressure Exercise

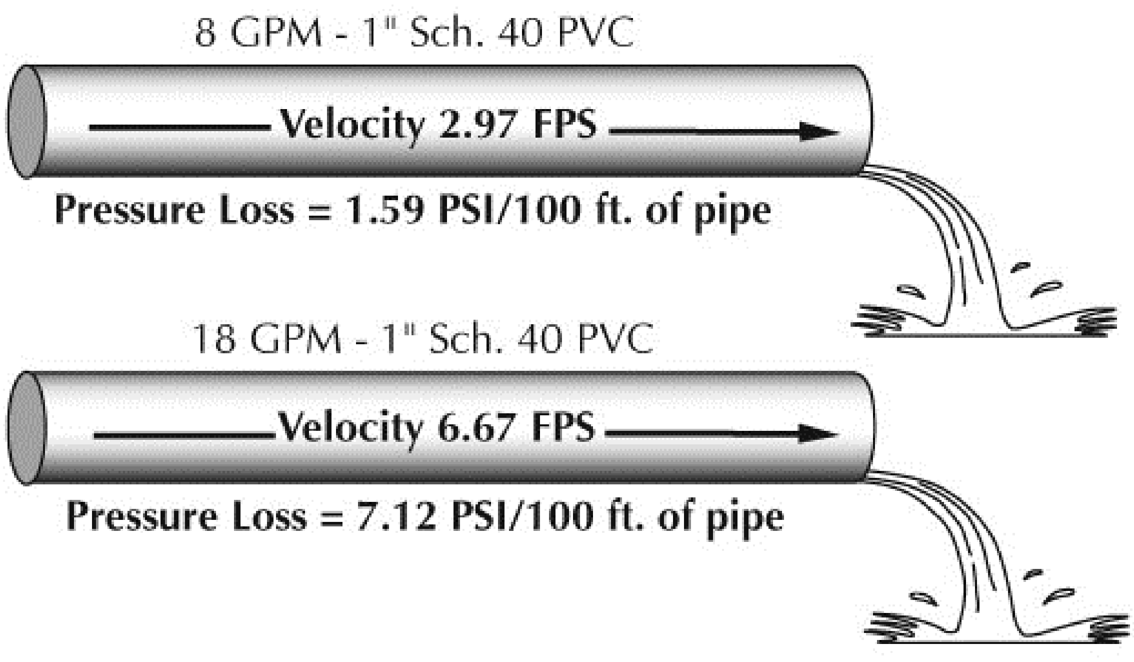
Dynamic Pressure

- static pressure + friction loss
- Movement of water in pipes

Factors that affect friction loss

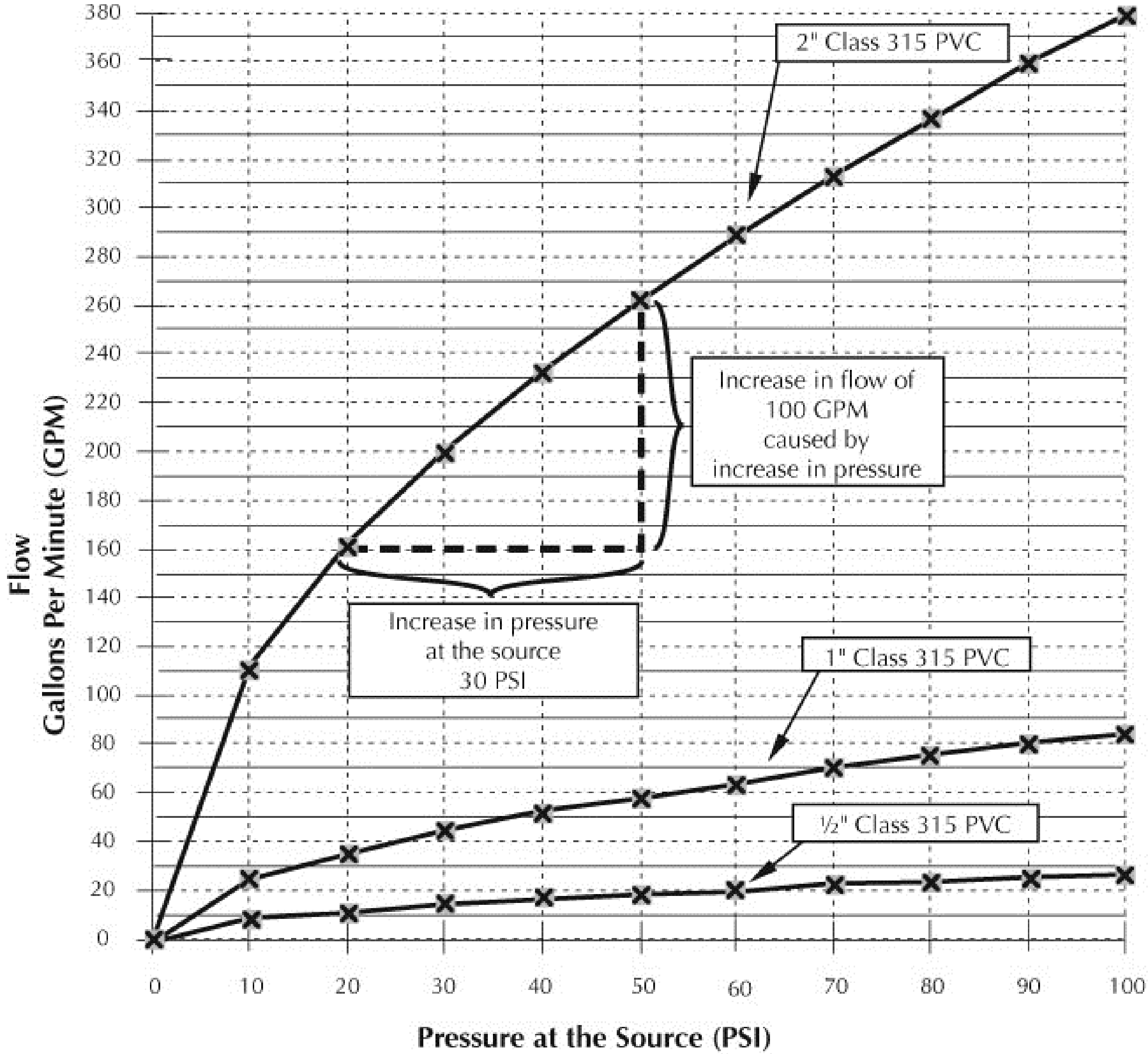
- Velocity
- Pipe diameter
- Roughness of inside walls of pipe
- Length of pipe

Velocity change



Effect of velocity on dynamic pressure

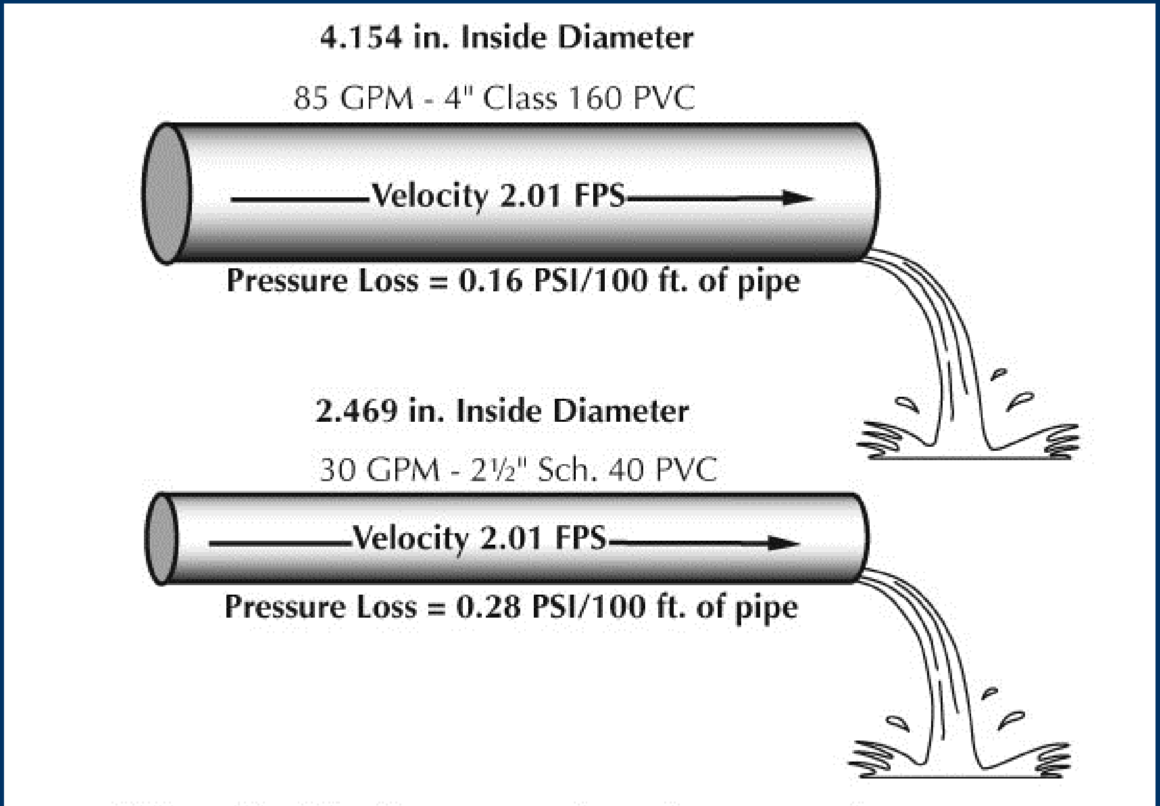
Increase velocity increases friction loss



** Approximate flow through an unrestricted 100-ft.-long section of pipe with four couplings. Pressure losses include: friction loss in pipe and couplings, velocity head and entrance losses. Exit losses not included.*

*The relationship of pressure and flow**

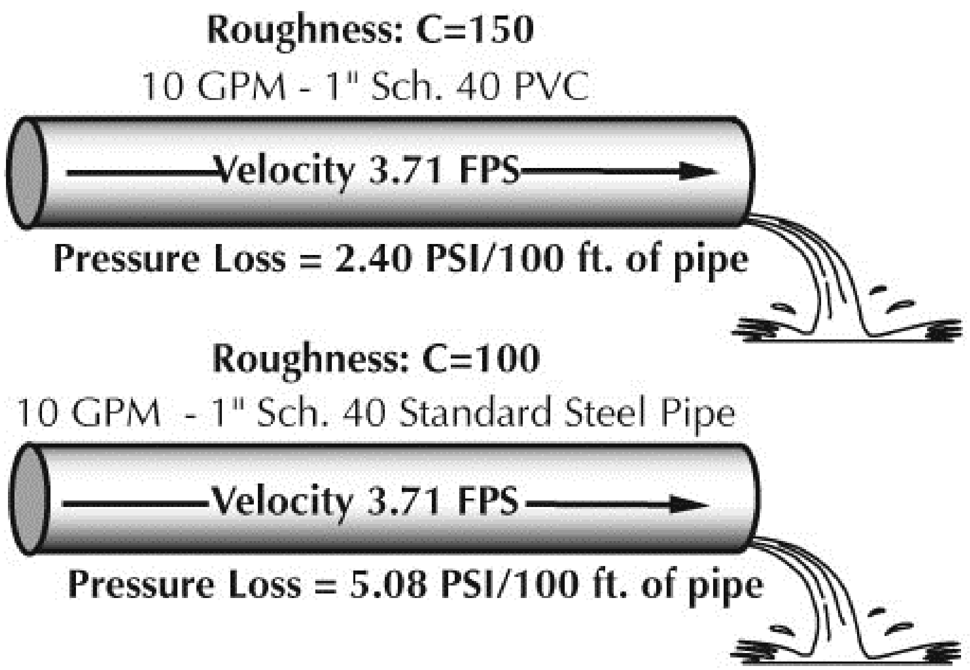
Pipe diameter change



Effect of inside diameter on dynamic pressure loss

Decrease in pipe diameter increases friction loss

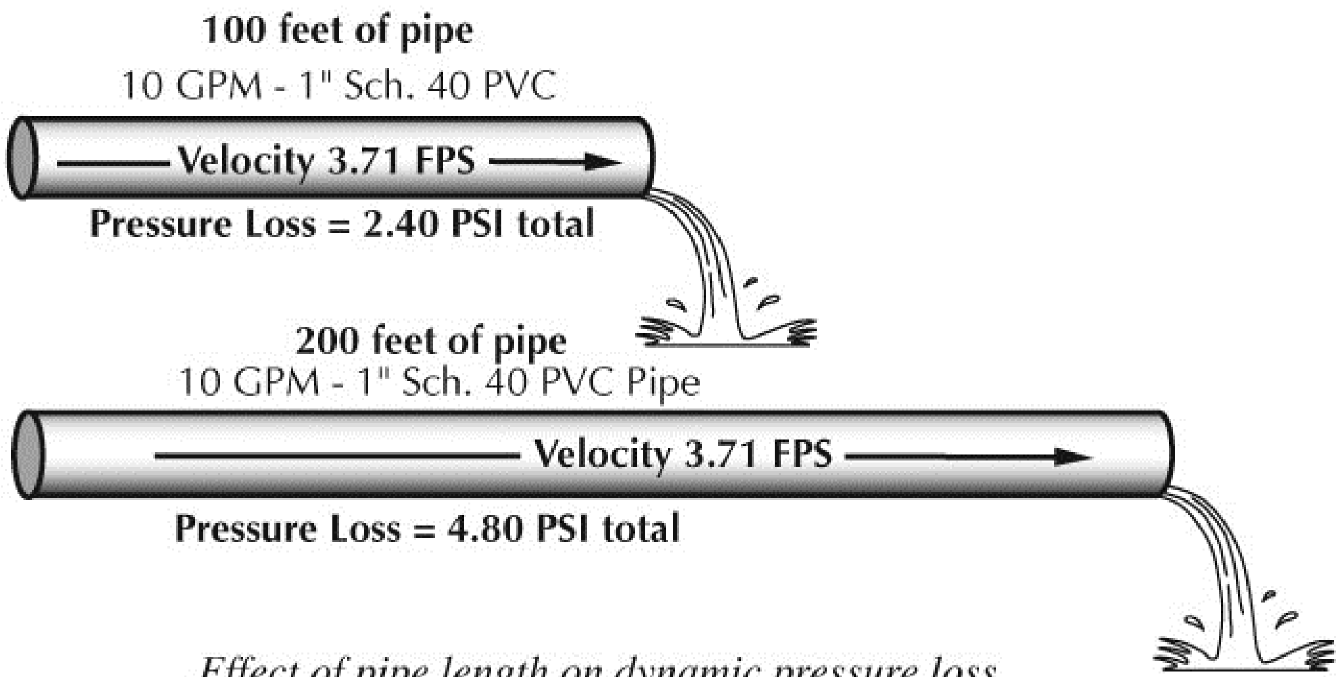
Change in Pipe Roughness



Effect of pipe wall roughness on dynamic pressure loss

Increase in pipe roughness increases friction loss

Change in Length



Effect of pipe length on dynamic pressure loss

Increase in pipe length increases friction loss

Hazen-Williams Formula

$$H_f = 0.090194\left(\frac{100}{C}\right)^{1.852}\frac{Q^{1.852}}{d^{4.866}}$$

Where H_f = pressure loss in pounds per square inch (PSI) per 100 ft. of pipe

C = roughness factor

Q = flow in gallons per minute (GPM)

d = inside pipe diameter in inches

Most common used formula for pressure loss in irrigation

Don't worry!
Charts are typically used for finding pressure loss in pipes

Irrigation Association Friction Loss Chart 2008

Schedule 40 PVC IPS Plastic Pipe

ASTM D1785 C=150

psi loss per 100 feet of pipe

Nominal Size	1/2"		3/4"		1"		1-1/4"		1-1/2"		2"	
Avg. ID	0.602		0.804		1.029		1.360		1.590		2.047	
Pipe OD	0.840		1.050		1.315		1.660		1.900		2.375	
Avg. Wall	0.119		0.123		0.143		0.150		0.155		0.164	
Min. Wall	0.109		0.113		0.133		0.140		0.145		0.154	
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	1.13	0.50	0.63	0.12	0.39	0.04	0.22	0.01	0.16	0.00		
2	2.25	1.82	1.26	0.44	0.77	0.13	0.44	0.03	0.32	0.02	0.19	0.00
3	3.38	3.85	1.89	0.94	1.16	0.28	0.66	0.07	0.48	0.03	0.29	0.01
4	4.50	6.55	2.52	1.60	1.54	0.48	0.88	0.12	0.65	0.06	0.39	0.02
5	5.63	9.91	3.16	2.42	1.93	0.73	1.10	0.19	0.81	0.09	0.49	0.03
6	6.75	13.89	3.79	3.40	2.31	1.02	1.32	0.26	0.97	0.12	0.58	0.04
7	7.88	18.48	4.42	4.52	2.70	1.36	1.54	0.35	1.13	0.16	0.68	0.05
8	9.01	23.66	5.05	5.79	3.08	1.74	1.76	0.45	1.29	0.21	0.78	0.06
9	10.13	29.43	5.68	7.20	3.47	2.17	1.99	0.56	1.45	0.26	0.88	0.08
10	11.26	35.77	6.31	8.75	3.85	2.63	2.21	0.68	1.61	0.32	0.97	0.09
12	13.51	50.14	7.57	12.27	4.62	3.69	2.65	0.95	1.94	0.44	1.17	0.13
14	15.76	66.71	8.84	16.32	5.39	4.91	3.09	1.26	2.26	0.59	1.36	0.17
16	18.01	85.42	10.10	20.90	6.17	6.29	3.53	1.62	2.58	0.76	1.56	0.22
18	20.26	106.24	11.36	25.99	6.94	7.82	3.97	2.01	2.90	0.94	1.75	0.28
20			12.62	31.59	7.71	9.51	4.41	2.45	3.23	1.14	1.95	0.33
22			13.89	37.69	8.48	11.35	4.85	2.92	3.55	1.37	2.14	0.40
24			15.15	44.28	9.25	13.33	5.29	3.43	3.87	1.60	2.34	0.47
26			16.41	51.36	10.02	15.46	5.74	3.98	4.20	1.86	2.53	0.54
28			17.67	58.91	10.79	17.73	6.18	4.56	4.52	2.13	2.73	0.62
30			18.94	66.94	11.56	20.15	6.62	5.19	4.84	2.42	2.92	0.71
32					12.33	22.71	7.06	5.85	5.16	2.73	3.12	0.80
34					13.10	25.41	7.50	6.54	5.49	3.06	3.31	0.89
36					13.87	28.24	7.94	7.27	5.81	3.40	3.51	0.99
38					14.64	31.22	8.38	8.04	6.13	3.76	3.70	1.10
40					15.41	34.33	8.82	8.84	6.46	4.13	3.89	1.21
42					16.18	37.58	9.26	9.67	6.78	4.52	4.09	1.32
44					16.95	40.96	9.71	10.54	7.10	4.93	4.28	1.44
46					17.73	44.47	10.15	11.45	7.42	5.35	4.48	1.57
48					18.50	48.12	10.59	12.39	7.75	5.79	4.67	1.69
50					19.27	51.90	11.03	13.36	8.07	6.25	4.87	1.83

Determining Dynamic Pressure Losses in Pipe

When calculating dynamic pressures we use the following factors:

A) Pressure change due to elevation change.[4]

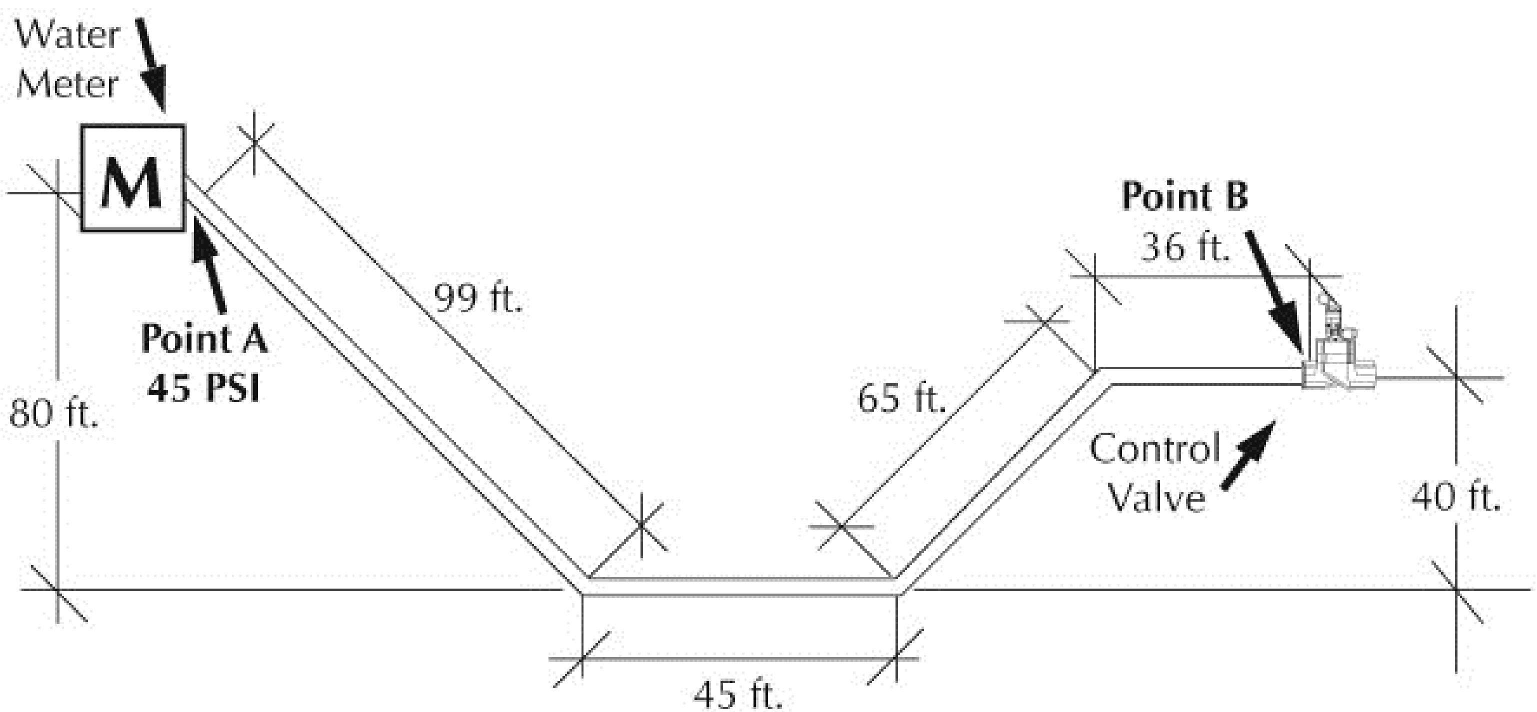
B) Pressure loss due to friction losses in the pipe (based on the factors mentioned on p. 12).

C) Pressure losses in valves, meters, etc. (These losses are determined by the manufacturer and listed in product literature or technical charts.)

D) Pressure losses due to fittings.
(See p. 40 for additional information.)

Dynamic Pressure Loss Exercise

In the diagram below, the pipe is 1" Class 315 PVC and the flow 12 GPM. If the dynamic pressure at point A is 45 PSI, what is the dynamic pressure at point B?



Elevation View

Dynamic Pressure Loss Exercise

PSI gain due to elevation change = 0.433 PSI per ft. x (80 ft. - 40 ft.)

PSI gain due to elevation change = 0.433 PSI per ft. x 40 ft.

PSI gain due to elevation change = 17.32 PSI

PSI loss in pipe = 2.43 PSI loss per 100 ft. x (99 ft. + 45 ft. + 65 ft. + 36 ft.)

PSI loss in pipe = 0.0243 per ft. x 245 ft.

PSI loss in pipe = 5.95 PSI

45.00	PSI pressure at point A
+17.32	PSI due to elevation change
62.32	PSI subtotal at point B
- 5.95	PSI due to friction loss in pipe
56.37	PSI dynamic pressure at point B

Irrigation Design Overview

Where do I start?

Schematic walkthrough of system

Materials review

Gather Site & System Information

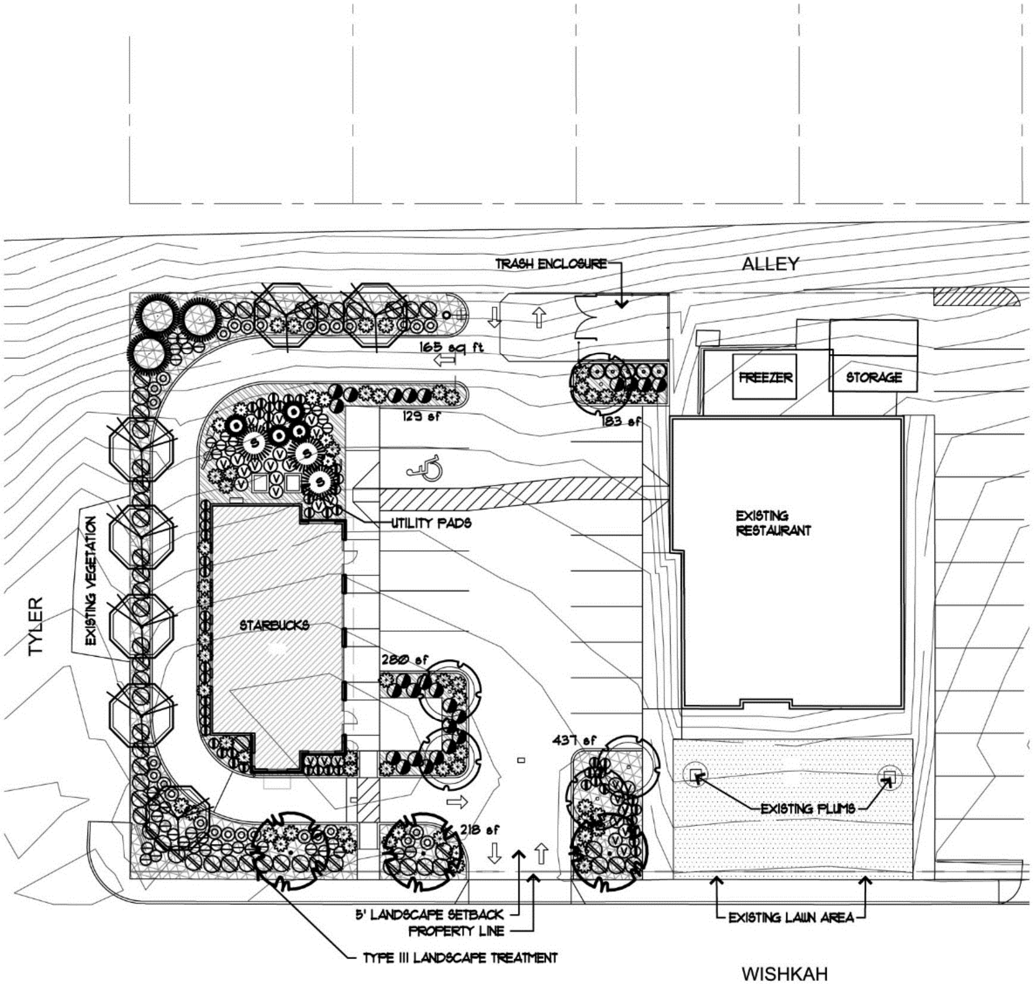
Site Information

- Vegetation to be irrigated
- Soil type
- Slope
- Utilities
- Obstructions

Water Source Information

- Source type, single or multiple
- Code and regulations
- Static pressure at site

What will be irrigated? Landscape Plan



LANDSCAPE PLANT SCHEDULE

DECIDUOUS TREES

KEY	COMMON NAME	BOTANICAL NAME	SIZE & NOTES
	Chanticleer Pear	Pyrus calleryana 'Chanticleer'	1-3/4" Cal., B & B
	Newport Plum	Prunus 'Newport'	1-3/4" Cal., B & B
	Pacific Sunset Maple	Acer pl. 'Warrenred'	1-3/4" Cal., B & B

EVERGREEN TREES

KEY	COMMON NAME	BOTANICAL NAME	SIZE & NOTES
	Omorika Spruce	Picea omorika	B&B, 6' Min. Ht.
	Mountain Hemlock	Tsuga mertensiana	B&B, 4'and 6' Min. Ht.

EVERGREEN SHRUBS

KEY	COMMON NAME	BOTANICAL NAME	SIZE & NOTES
	Dwarf Red-Twig Dogwood	Cornus stolinefera 'Kelsyi'	2 Gal. Cont.
	Emerald green Arborvitae	tsuga occidentalis 'Emerald green'	4' Ht., B & B
	Laurustinus	Viburnum tinus	5 Gal. Cont.
	White Rockrose	Cystus corbariensis 'hybridus'	5 Gal. Cont.
	Dwarf Fountain Grass	Pennisetum orientale 'Hamelin'	1 Gal. Cont.
	Midwinter Fire Dogwood	Cornus stolinifera 'Midwinters Fire'	2 Gal. Cont.
	Goldflame Spirea	Spireae 'Goldflame'	2 Gal. Cont.
	David's Viburnum	Viburnum davidii	5 Gal. Cont.

GROUNDCOVERS

KEY	COMMON NAME	BOTANICAL NAME	SIZE & NOTES
	Kinnikinnick	Arctostaphylus uva-ursa	1 Gal. Cont, 24" O.C.
	Taiwan Bramble	Rubus pentalobis	1 Gal. Cont, 24" O.C.

EXISTING VEGETATION

KEY	COMMON NAME	BOTANICAL NAME	SIZE & NOTES
	Plum Tree		
	Lawn Area		

Plant Types

Is it this?

Or this?

Soil Type and Intake Rates

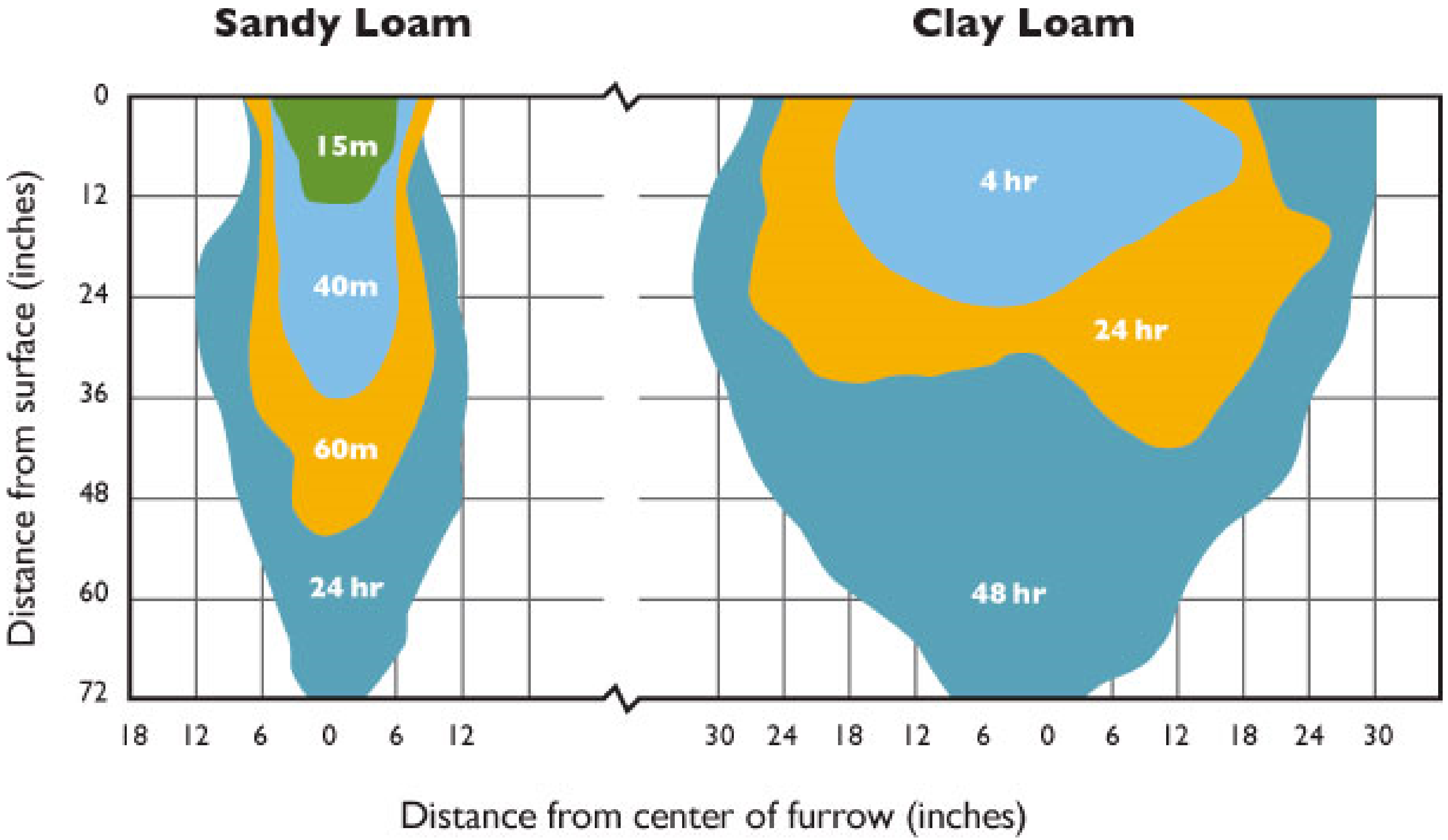
SOIL TEXTURE	SOIL INTAKE RATES (inches per hour)							
	0 to 5% slope		5 to 8% slope		8 to 12% slope		12%+ slope	
	Cover	Bare	Cover	Bare	Cover	Bare	Cover	Bare
Coarse sandy soils	2.00	2.00	2.00	1.50	1.50	1.00	1.00	0.50
Coarse sandy soils over compact subsoils	1.75	1.50	1.25	1.00	1.00	0.75	0.75	0.40
Uniform light sandy loams	1.75	1.00	1.25	0.80	1.00	0.60	0.75	0.40
Light sandy loams over compact subsoils	1.25	0.75	1.00	0.50	0.75	0.40	0.50	0.30
Uniform silt loams	1.00	0.50	0.80	0.40	0.60	0.30	0.40	0.20
Silt loams over compact subsoil	0.60	0.30	0.50	0.25	0.40	0.15	0.30	0.10
Heavy clay or clay loam	0.20	0.15	0.15	0.10	0.12	0.08	0.10	0.06

Soil Intake Rates for Various Soil Textures

Figure 52

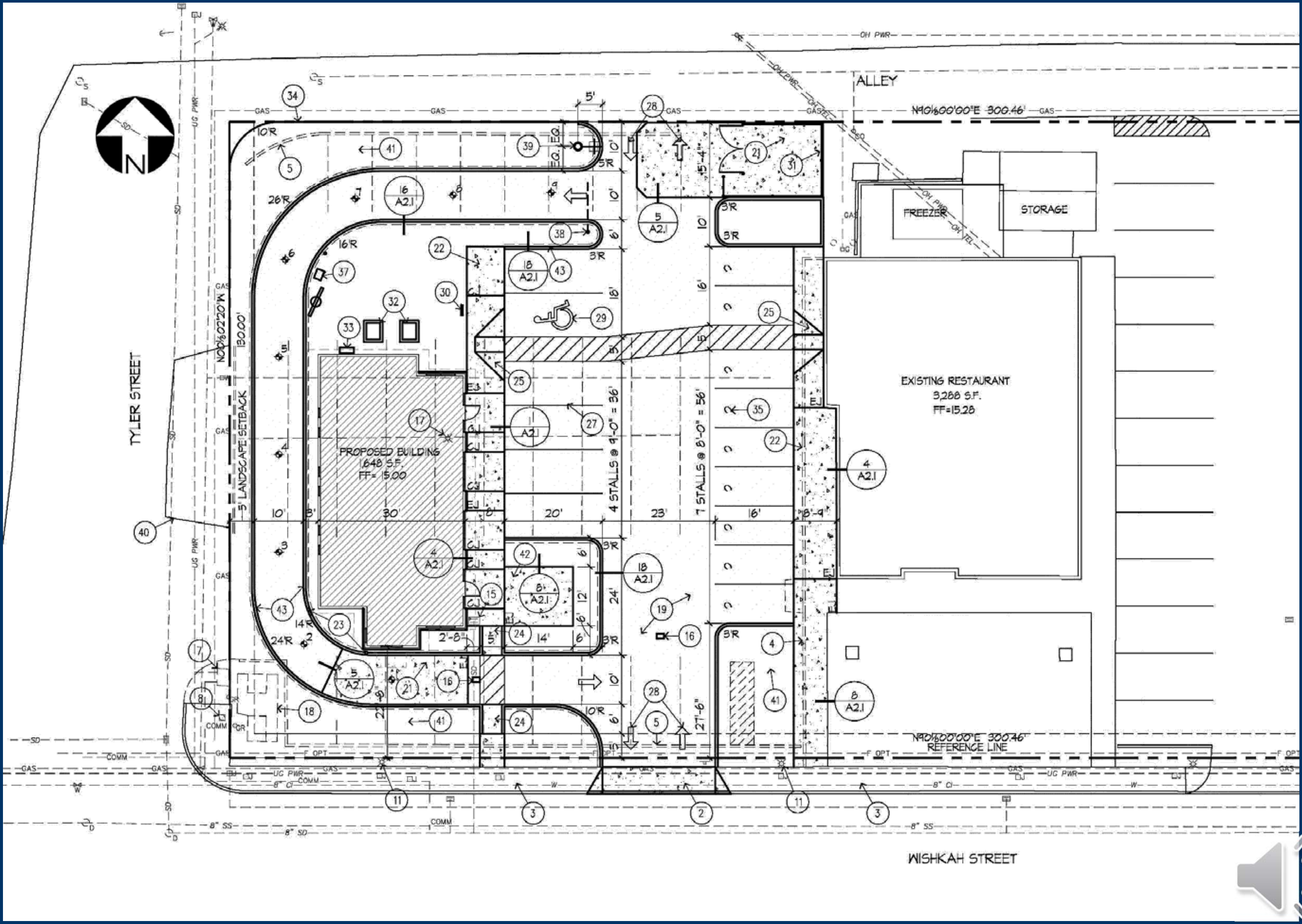
The maximum precipitation-rate values listed are as suggested by the United States Department of Agriculture. The values are average and may vary with respect to actual soil conditions and condition of the ground cover.

Soil Type and Intake Rates



Infiltration of two different soil types measured in time and area wetted.

Utilities and Obstructions



Site & System Information

Water Source

Where are you getting your water from?

- City or public supply
- Rainwater harvest tank
- Pond or lake
- Well

Items to know

- Codes and regulations
- Water quality
- Static pressure at site / pump needed?

Site & System Information

Codes & Regulations

- Typically found in landscape code section
- Be sure and check water code for other requirements
- City of Spokane example
- Minimal code language and regulations
- City of Bellevue example
- Significant code requirements

Site & System Information

Codes & Regulations
Spokane

- Sections 17C.200.100 & 17C.200.110
- Automatic irrigation is required in public spaces
- Water conservation measures (section 110)

  Hydrozones
  Soil amendments
  Lawn controls
  Existing vegetation retention

Site & System Information

Codes & Regulations
Bellevue

- Sections 20.20.520 - Landscape Code
  - Irrigation plan required
- Section 24.02.205 – Irrigation Water Budget Requirement
- Specific requirements and calculations

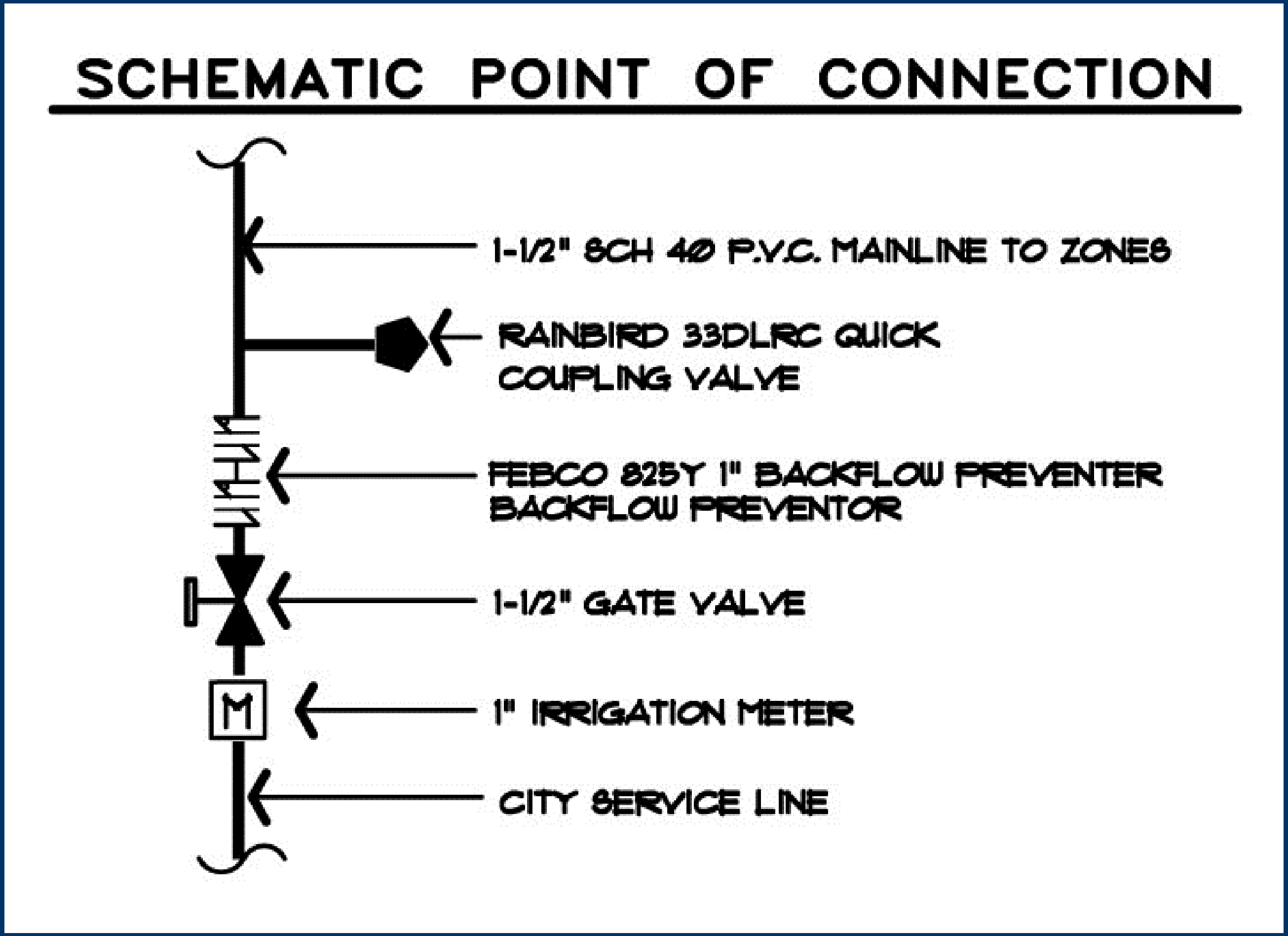
Water Source / Point of Connection

Connecting to a water source

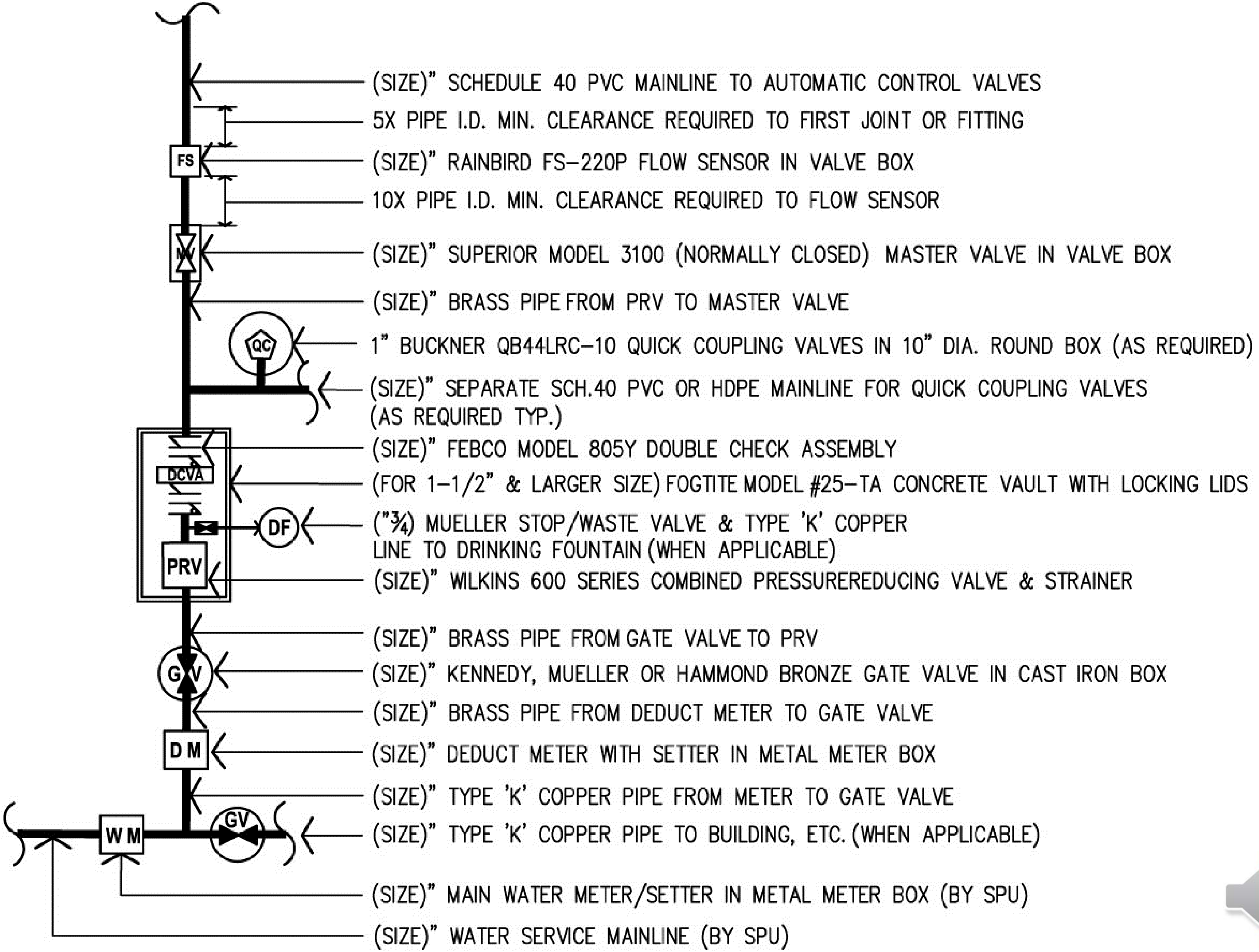
Typical Components

- Source / City supply line
- Service tap
- Meter (shared, deduct, isolated)
- Backflow prevention
- Flow sensor, master valve, quick coupler

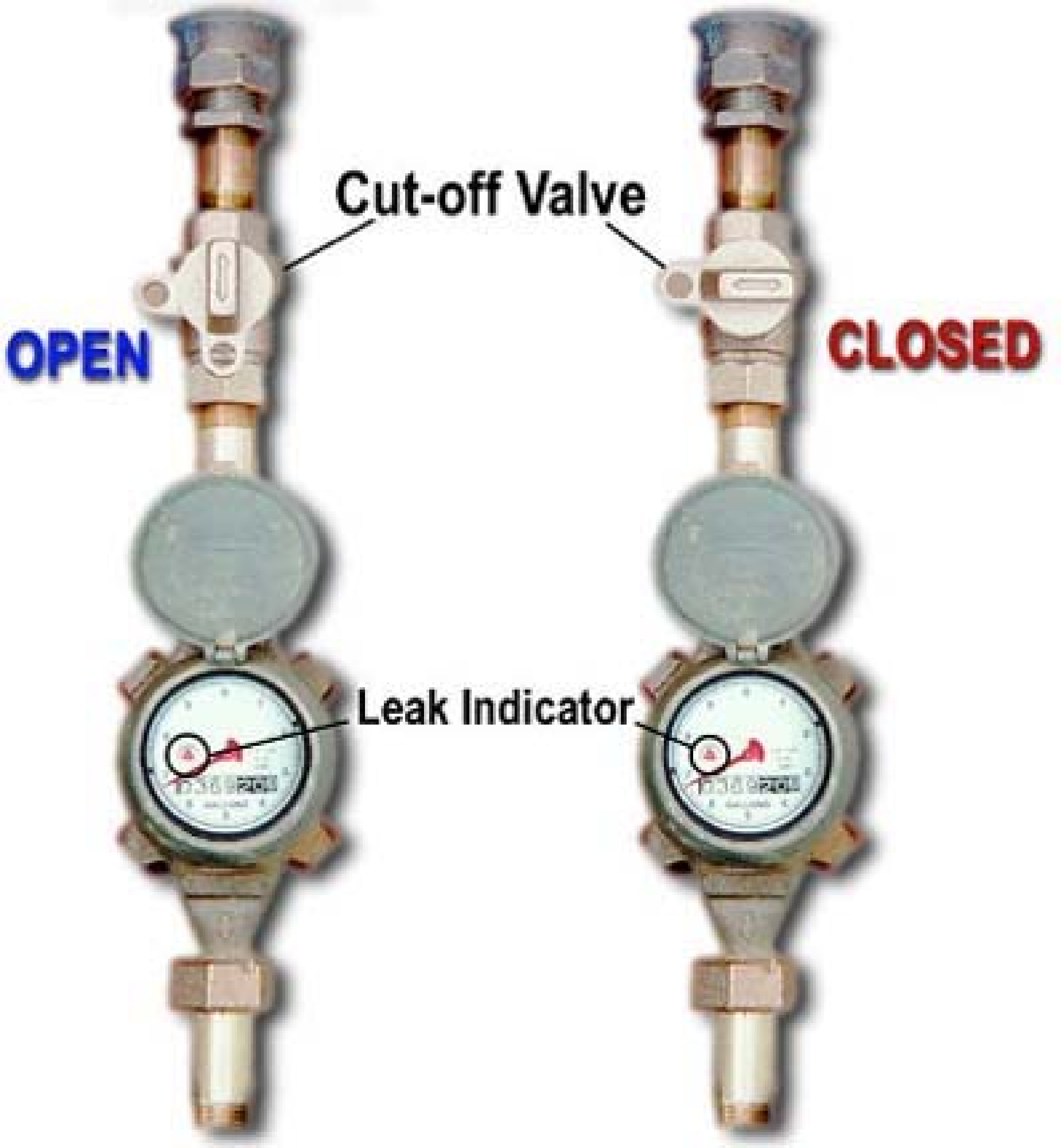
Point of Connection / Water Supply



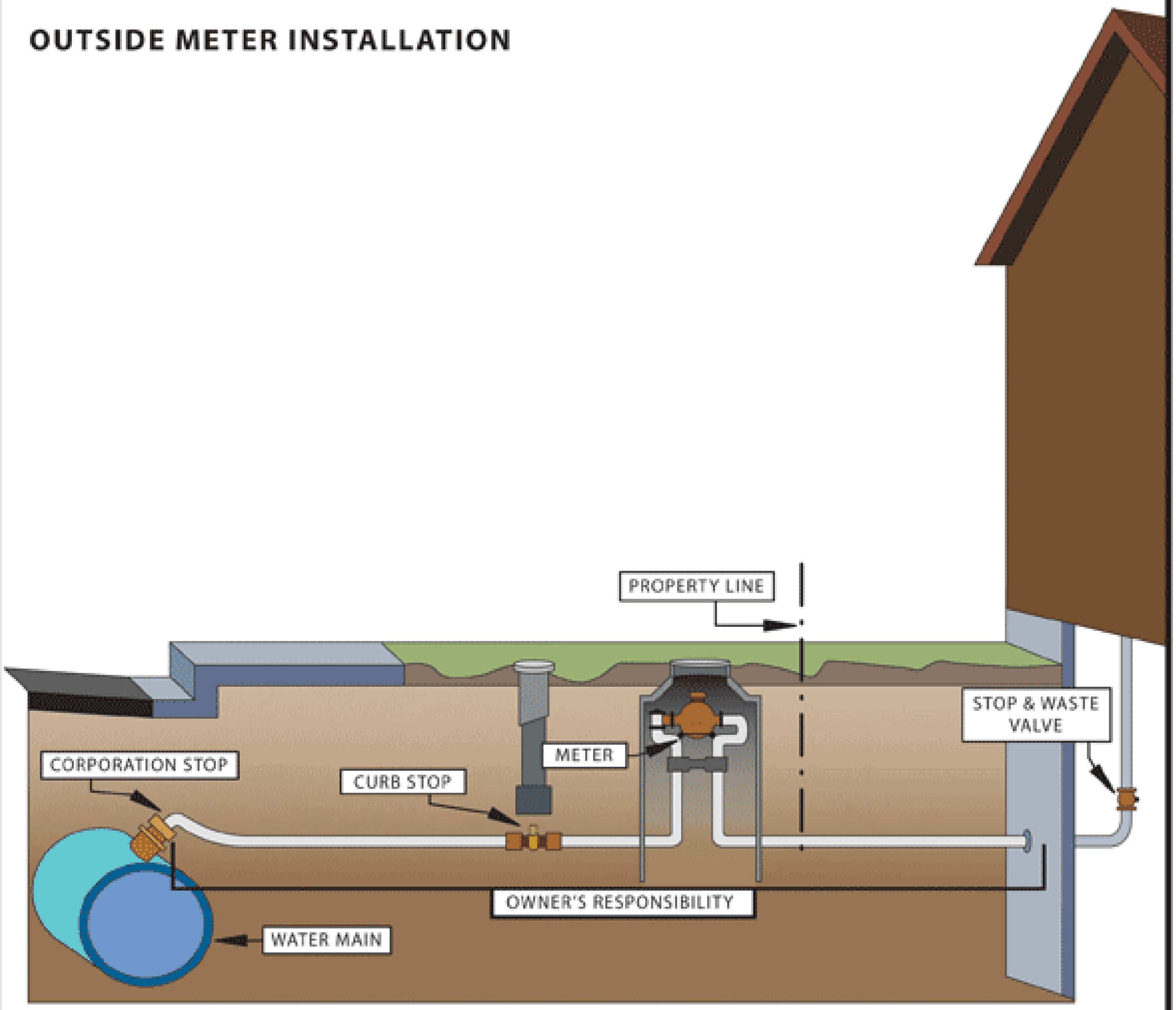
Seattle Parks POC



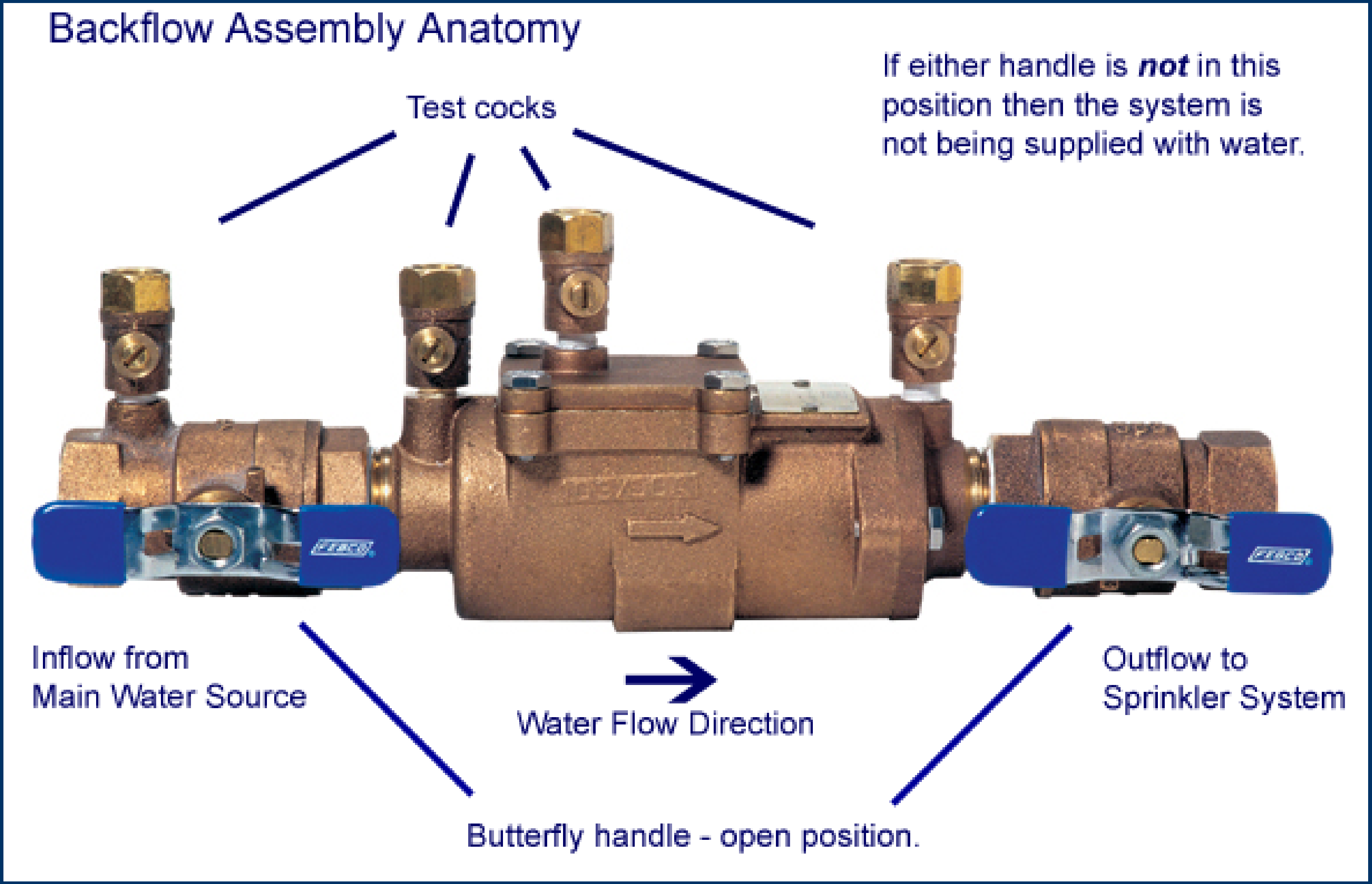
Water Meter



OUTSIDE METER INSTALLATION



Backflow Prevention



Point of Connection

ES-F-850S

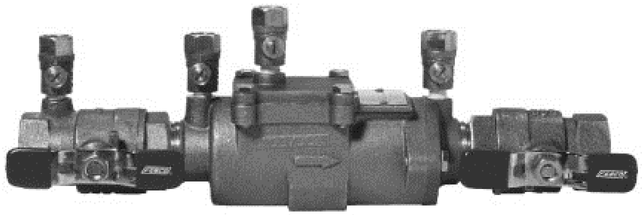
SPECIFICATION SHEET FEBCO®

Series 850

Double Check Valve Assemblies

Size: ½" - 2" (15mm - 50mm)

The FEBCO Series 850 Double Check Valve Assemblies are designed for non-health hazard applications. End Connections – NPT ANSI / ASME B1.20.1



Series 850

Pressure – Temperature

Max. Working Pressure:	175psi (12.1 bar)
Hydrostatic Test Press:	350psi (24.1 bar)
Temperature Range:	32°F to 140°F (0°C to 60°C)

Materials

Valve Body:	Bronze
Elastomers:	Silicone
Springs:	Stainless Steel

Models

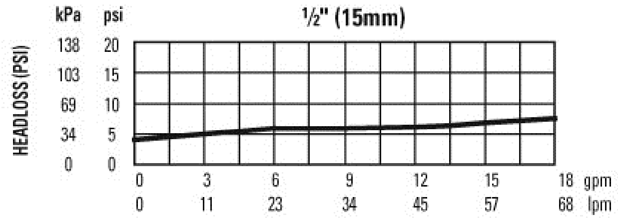
- Wye - Strainer

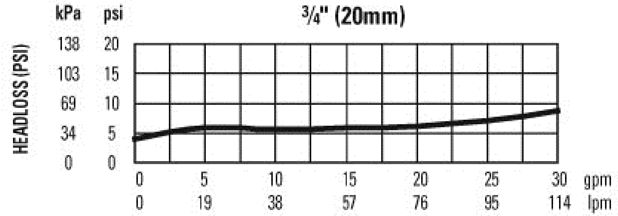
Approvals – Standards

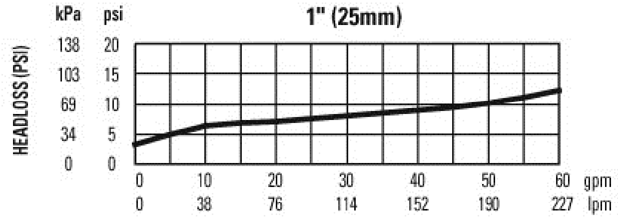
- ANSI/AWWA Conformance (C510-92)
- Approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California.

1015 B64.5

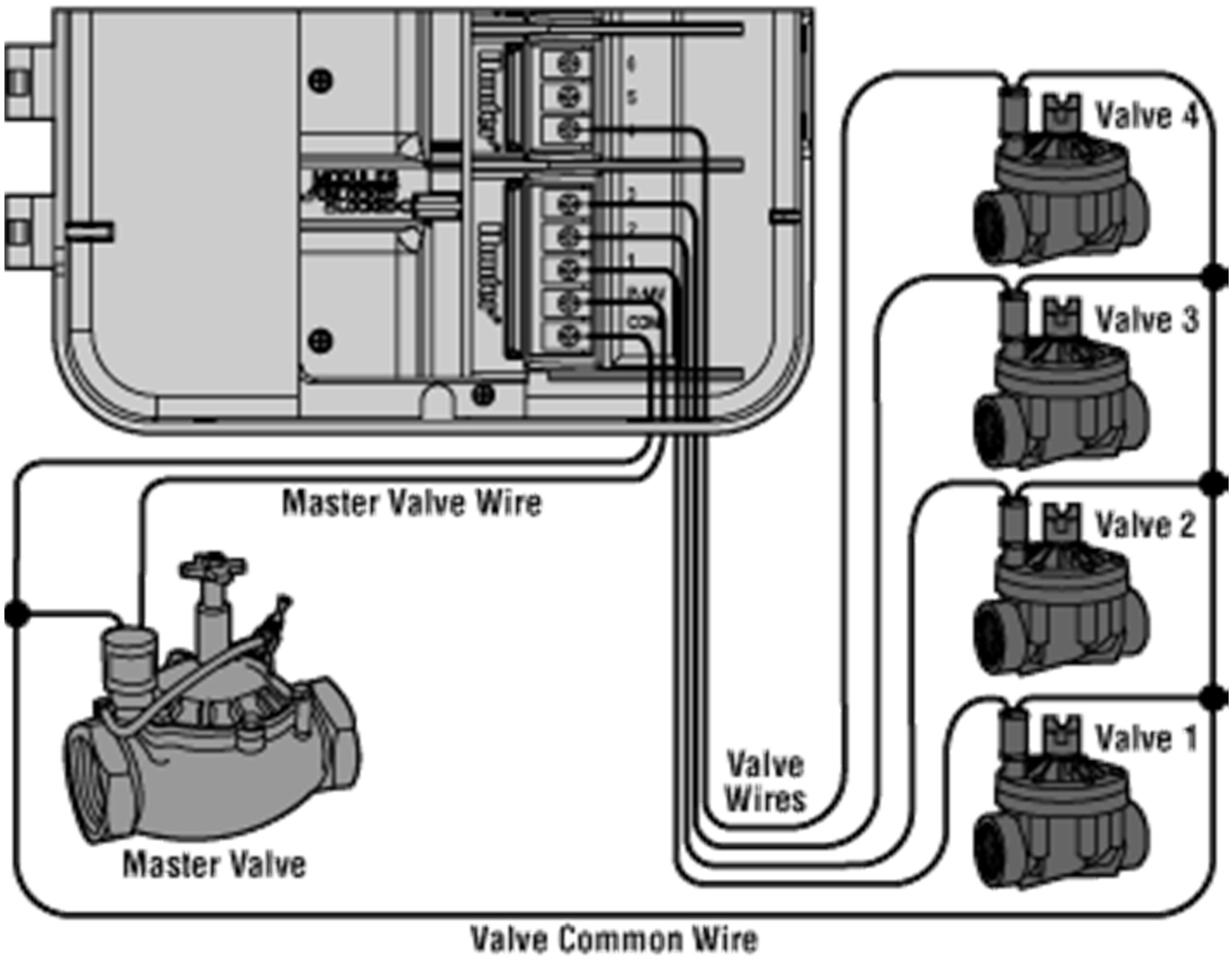
Capacity







Master Valve Connection



Sprinkler Head Types & Layout

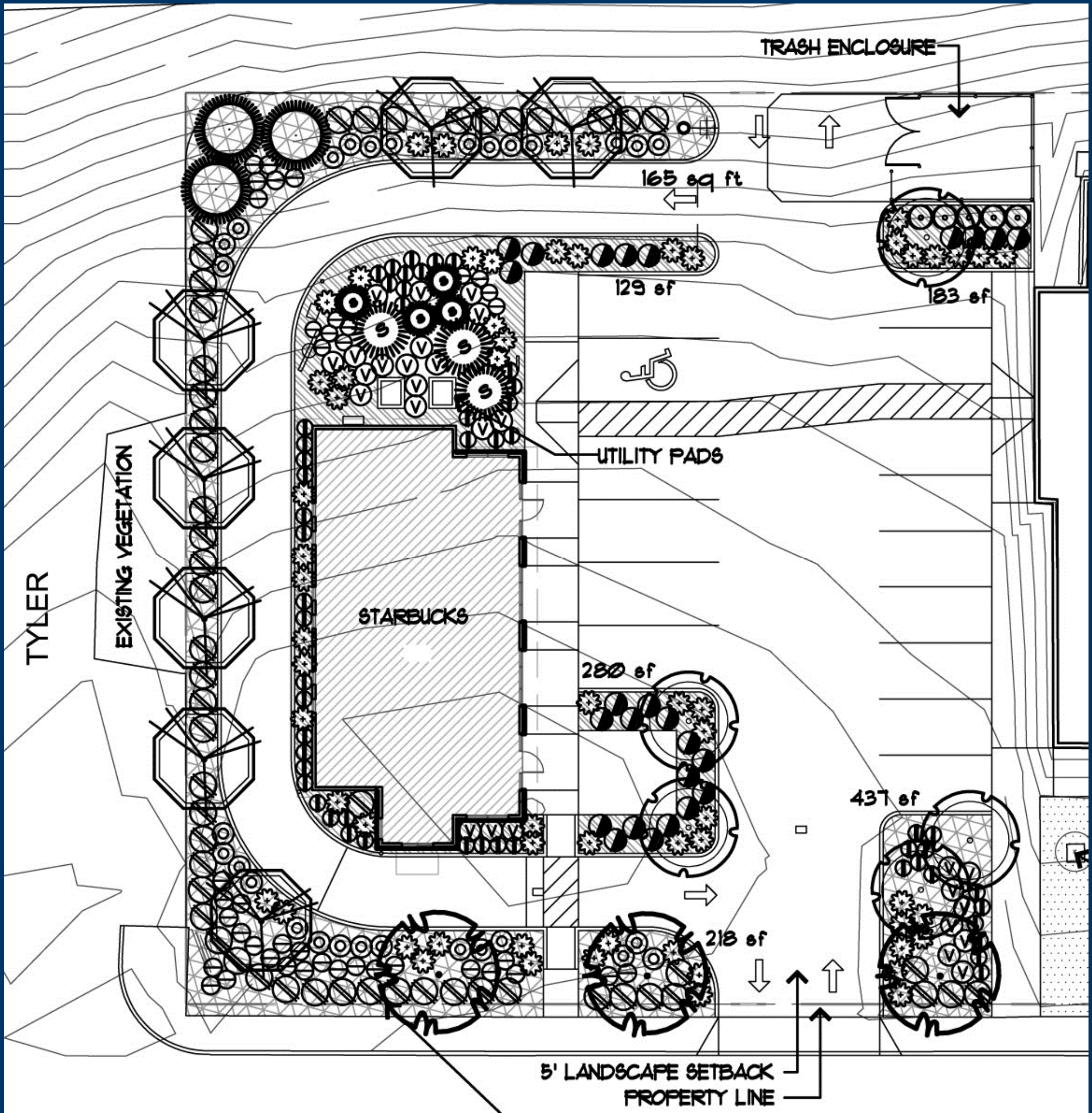
Types of sprinkler heads

- Pop-up spray head
- Rotor head
- Impact head

Selection & Layout Considerations

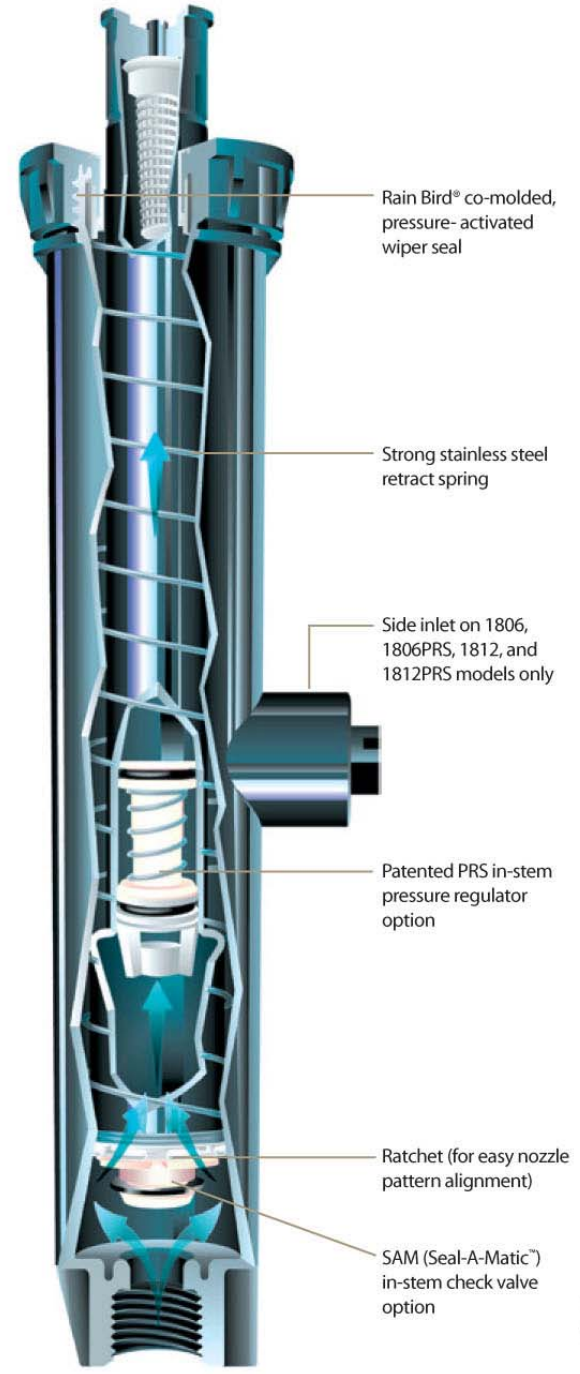
- Vegetation type
- Size of landscape bed
- Precipitation rate
- Soil type
- Client desires
- Codes and regulations

Landscape Plan



Pop-Up Spray Head

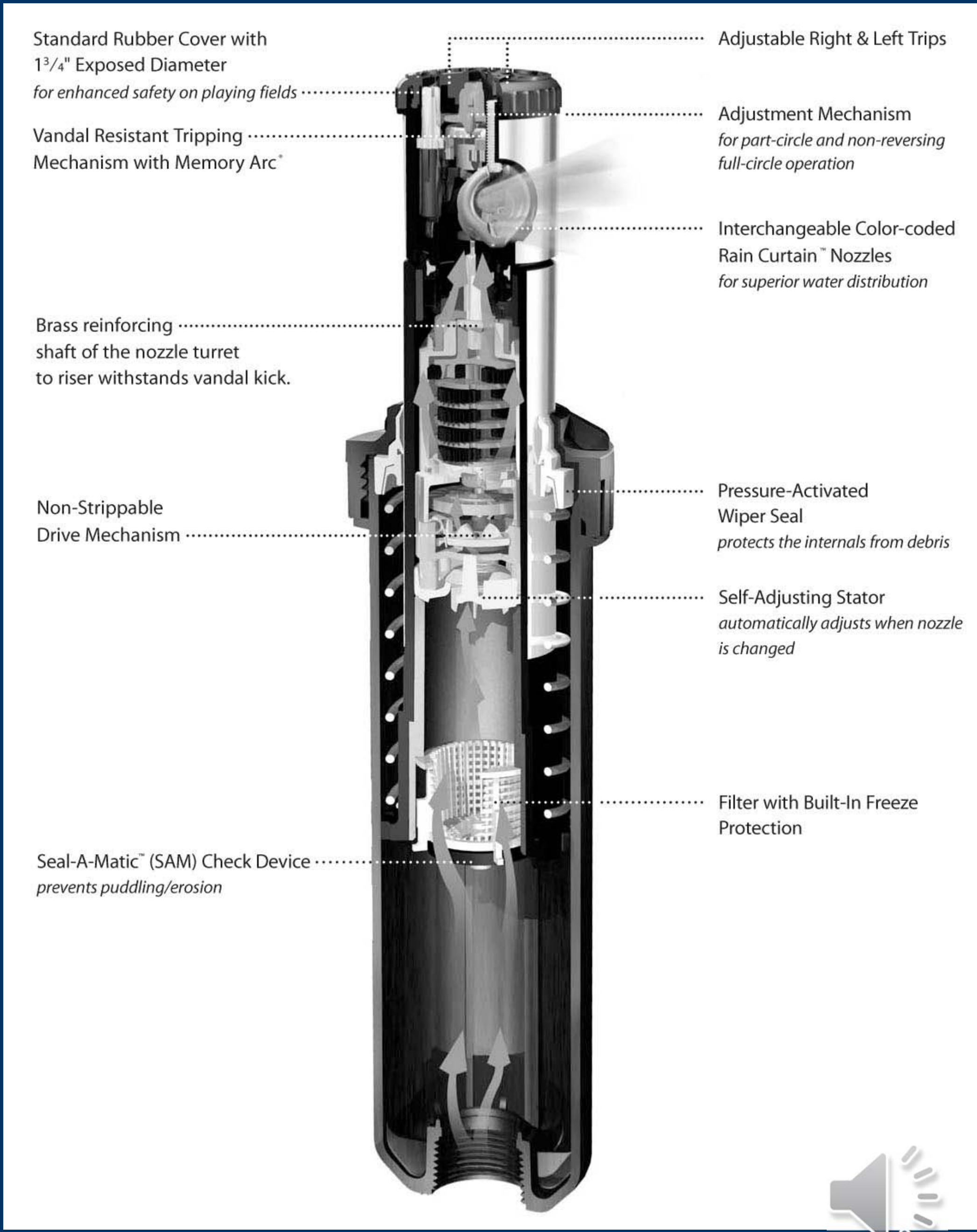
- Typically used in smaller spaces
- 5ft – 18ft throw radius
- 15 – 70 psi range
- 30 psi optimum
- High precipitation rates
- Wide selection of nozzles
- Most common sprinkler
- 4”, 6”, and 12” sizes



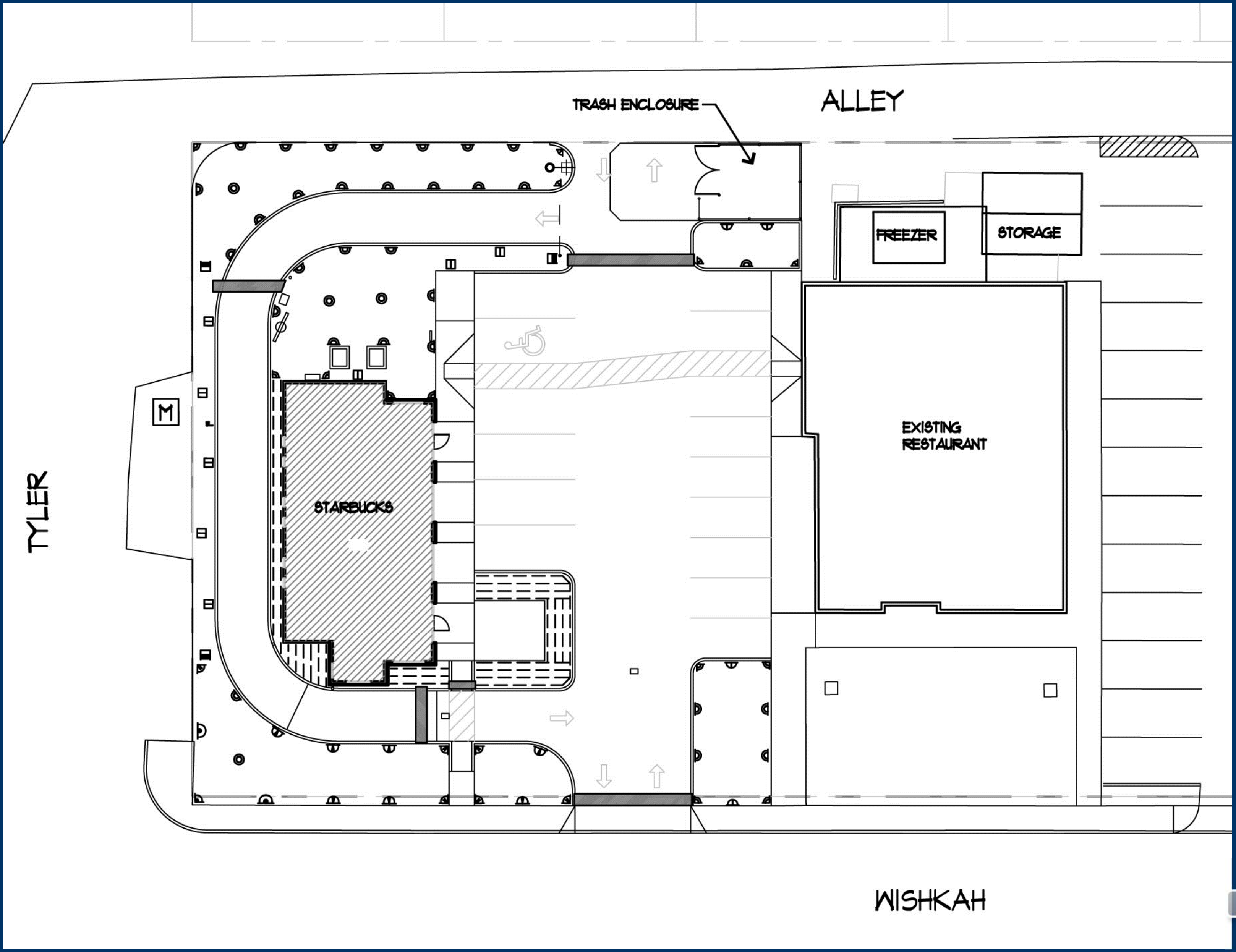
Rotor Head

- Typically used in larger planting areas or lawns
- 17ft – 80ft throw radius
- 30 – 100 psi range
- 50 psi optimum
- Low precipitation rates
- Wide selection of nozzles and models

5”, 6”, and 10” sizes

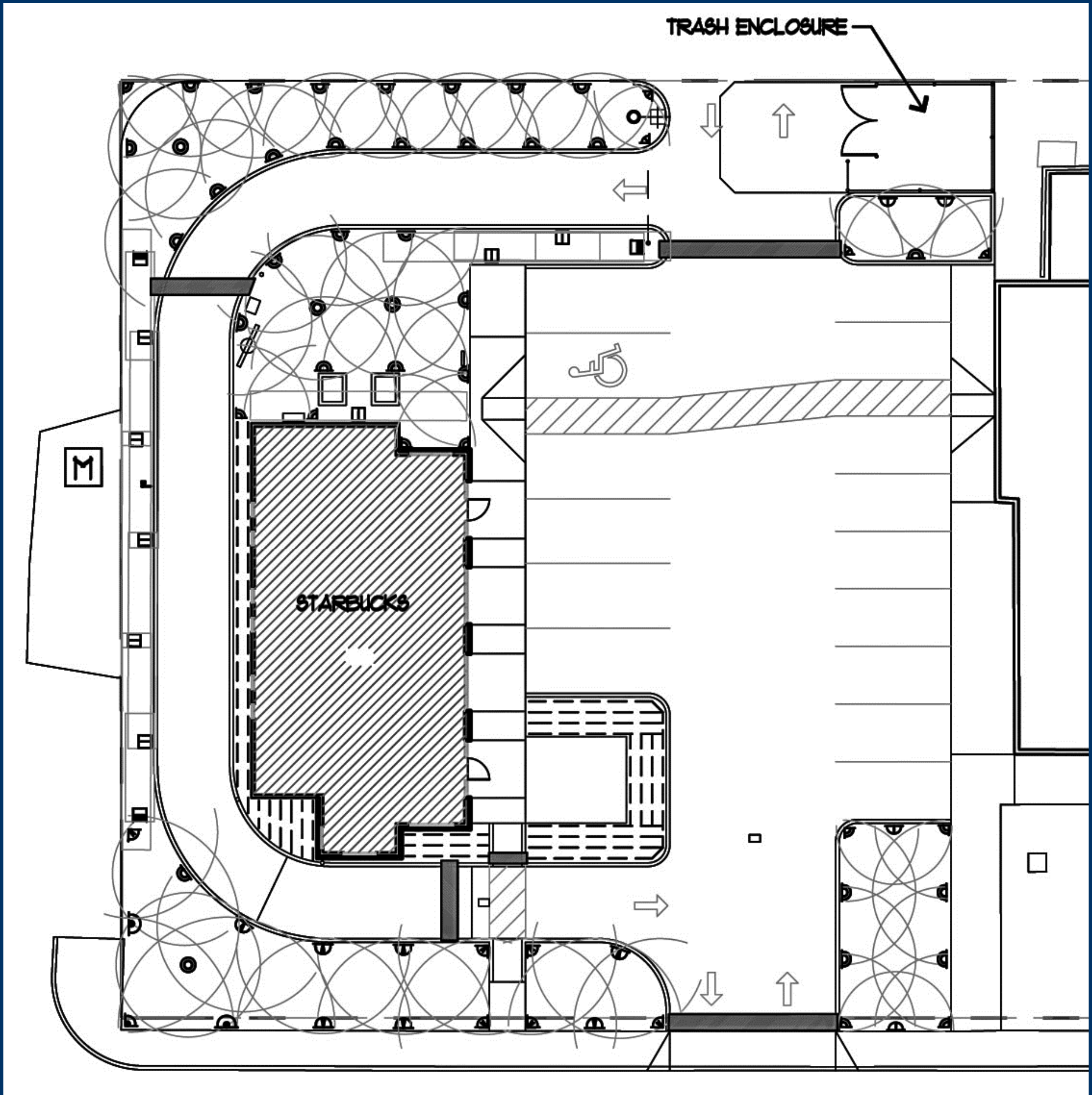


Head Layout

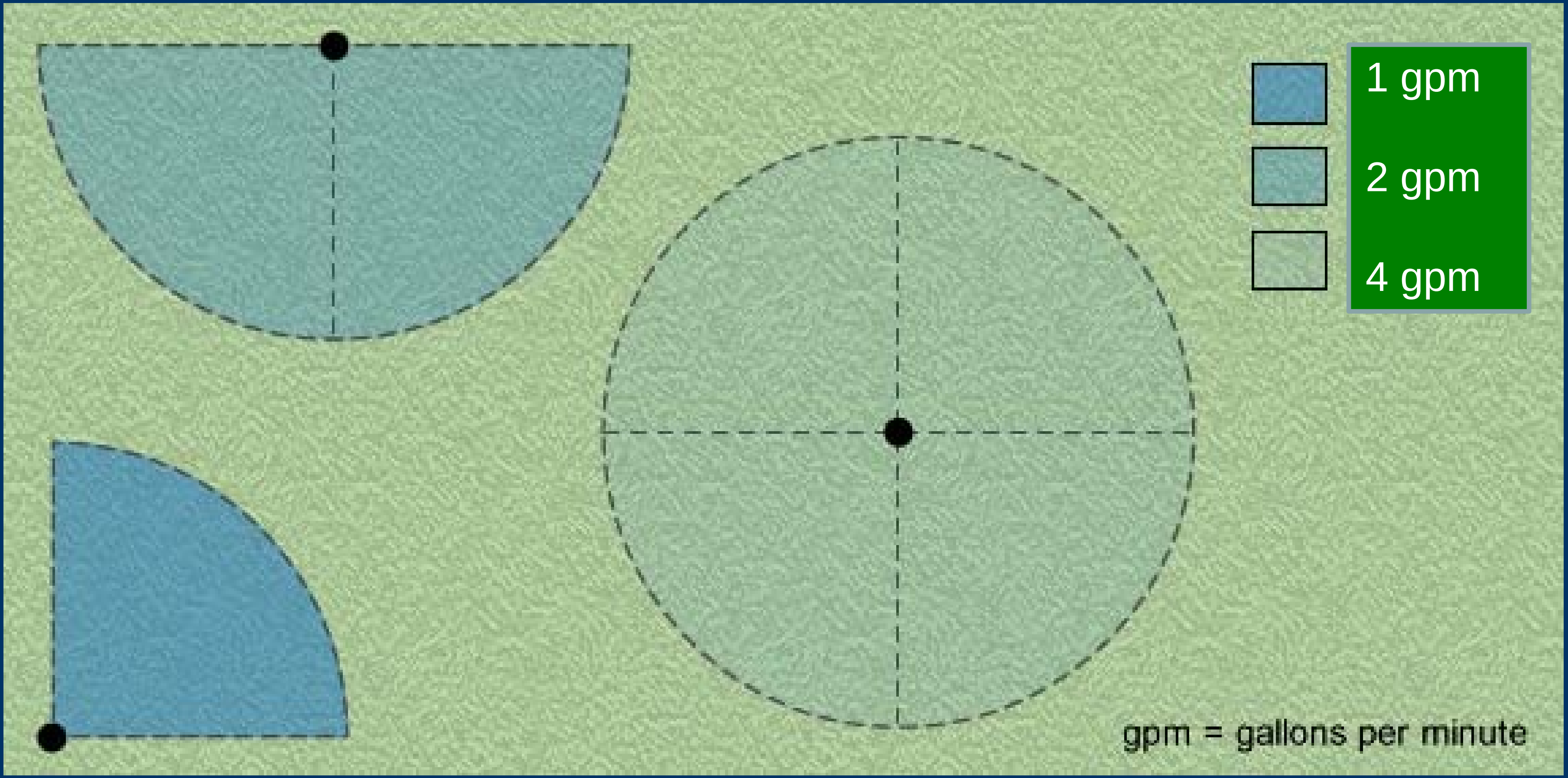


TRASH ENCLOSURE
ALLEY
FREEZER
STORAGE
TYLER
STARBUCKS
EXISTING RESTAURANT
WISHKAH

Head Layout



Head Layout & Precipitation Rate



Head Layout & Precipitation Rate

$$PR = \frac{96.3 \times \text{gpm (applied to the area)}}{S \times L}$$

$$\left(PR = \frac{1000 \times m^3/h \text{ [applied to the area]}}{S \times L} \right)$$

Where:

PR	=	the average precipitation rate in inches per hour	PR	=	the average precipitation rate in millimeters per hour
96.3	=	a constant which incorporates inches per square foot per hour	1000	=	a constant which converts meters to millimeters
gpm	=	the total gpm applied to the area by the sprinklers	m^3/h	=	the total m^3/h applied to the area by the sprinklers
S	=	the spacing between sprinklers	S	=	the spacing between sprinklers
L	=	the spacing between rows of sprinklers	L	=	the spacing between rows of sprinklers

Head Layout & Precipitation Rate

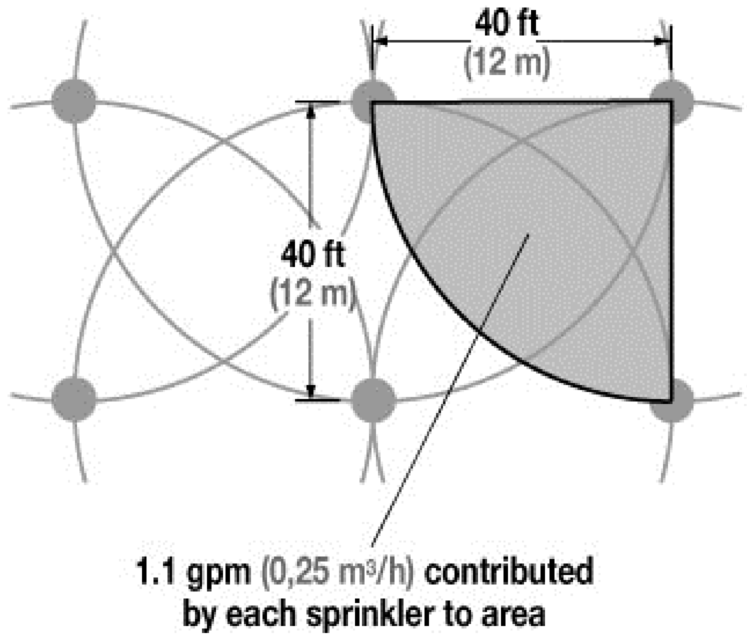


Figure 43: Square sprinkler spacing pattern with full circle sprinkler

The formula for this example would be:

$$PR = \frac{96.3 \times 4.4 \text{ gpm}}{40 \text{ ft} \times 40 \text{ ft}} = \frac{423.72}{1600} = .2648 \text{ in/h}$$

$$\left(PR = \frac{1000 \times 1 \text{ m}^3/\text{h}}{12 \text{ m} \times 12 \text{ m}} = \frac{1000}{144} = 6{,}94 \text{ mm/h} \right)$$

Head Layout & Precipitation Rate

Spray sprinklers have fixed arcs of coverage and some have matched precipitation rates. Let's look at a PR calculation for four spray sprinklers in the corner of a lawn area with these statistics:

Spacing: S = 11 ft (3 m), L = 12 ft (4 m)
Operating pressure at the sprinklers = 25 psi (1,7 bar)
Radius of throw = 11 ft (3 m), regardless of pattern
Discharge: Full circle = 2.4 gpm (0,56 m^3/h)
Half circle = 1.2 gpm (0,28 m^3/h)
Quarter circle = .6 gpm (0,14 m^3/h)

The spacing pattern might look like this:

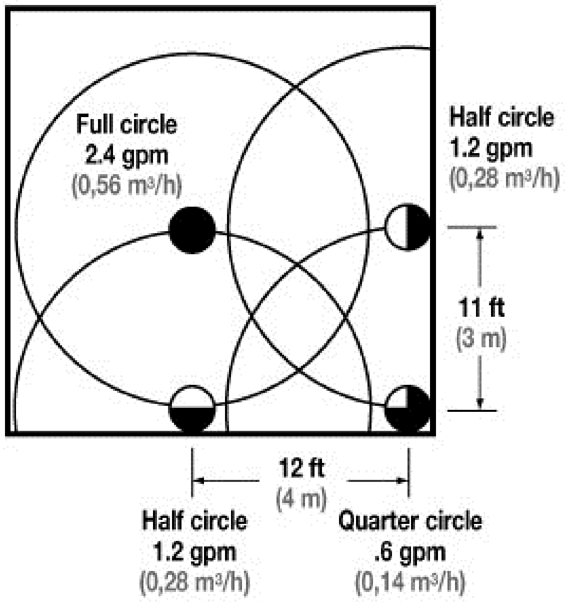


Figure 45: PR calculation for four spray heads

Creating Spray Head & Rotor Zones

Factors to consider when creating a zone

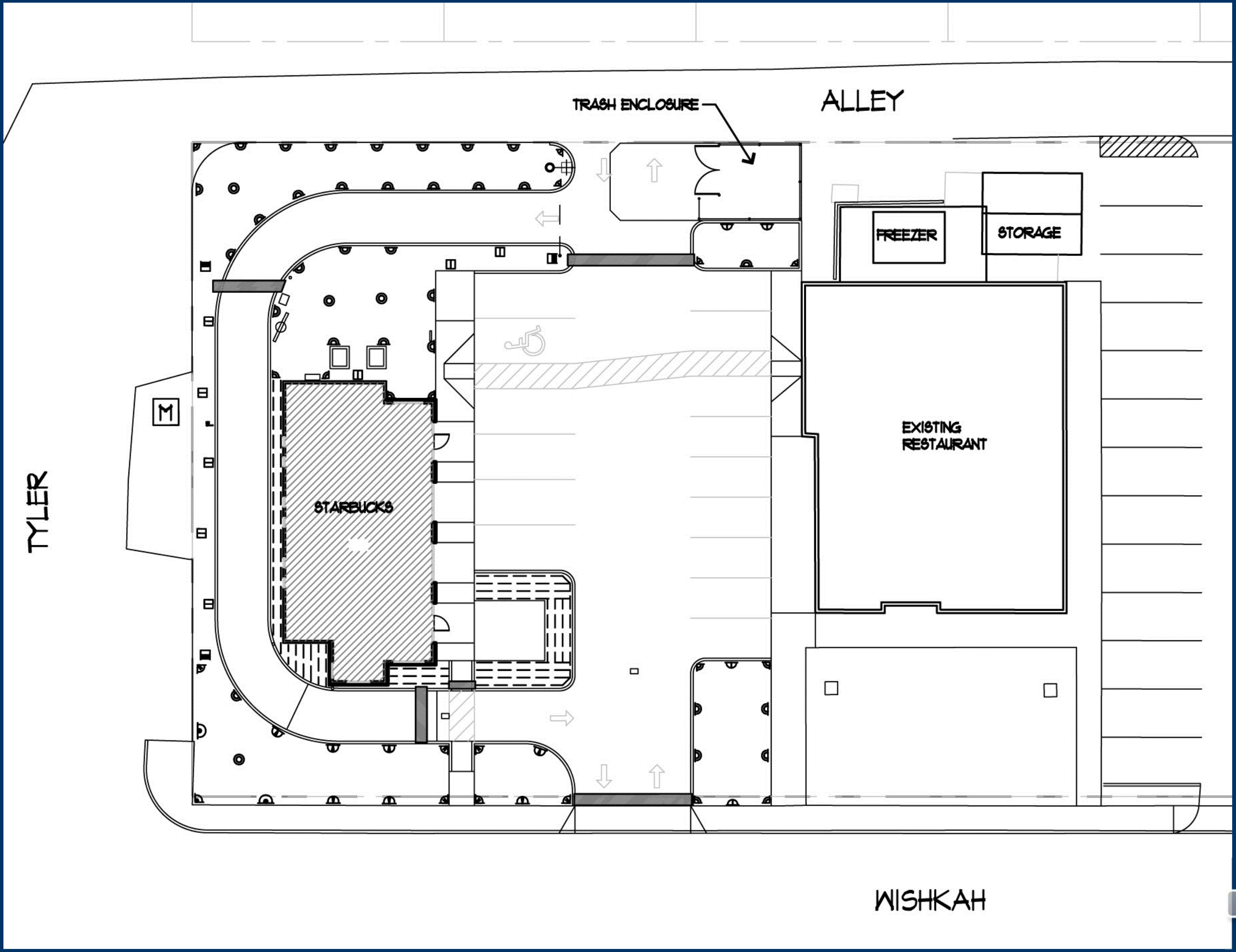
- Number of heads in zone (GPM cap)
- Valve location and size
- Mainline routing
- Landscape types and hydrozone considerations
- Calculate GPM (or GPH for drip)

Creating Spray Head & Rotor Zones

GPM Cap

- Meter flow
- Mainline size
- Valve size
- What is the bottleneck that controls GPM per zone?

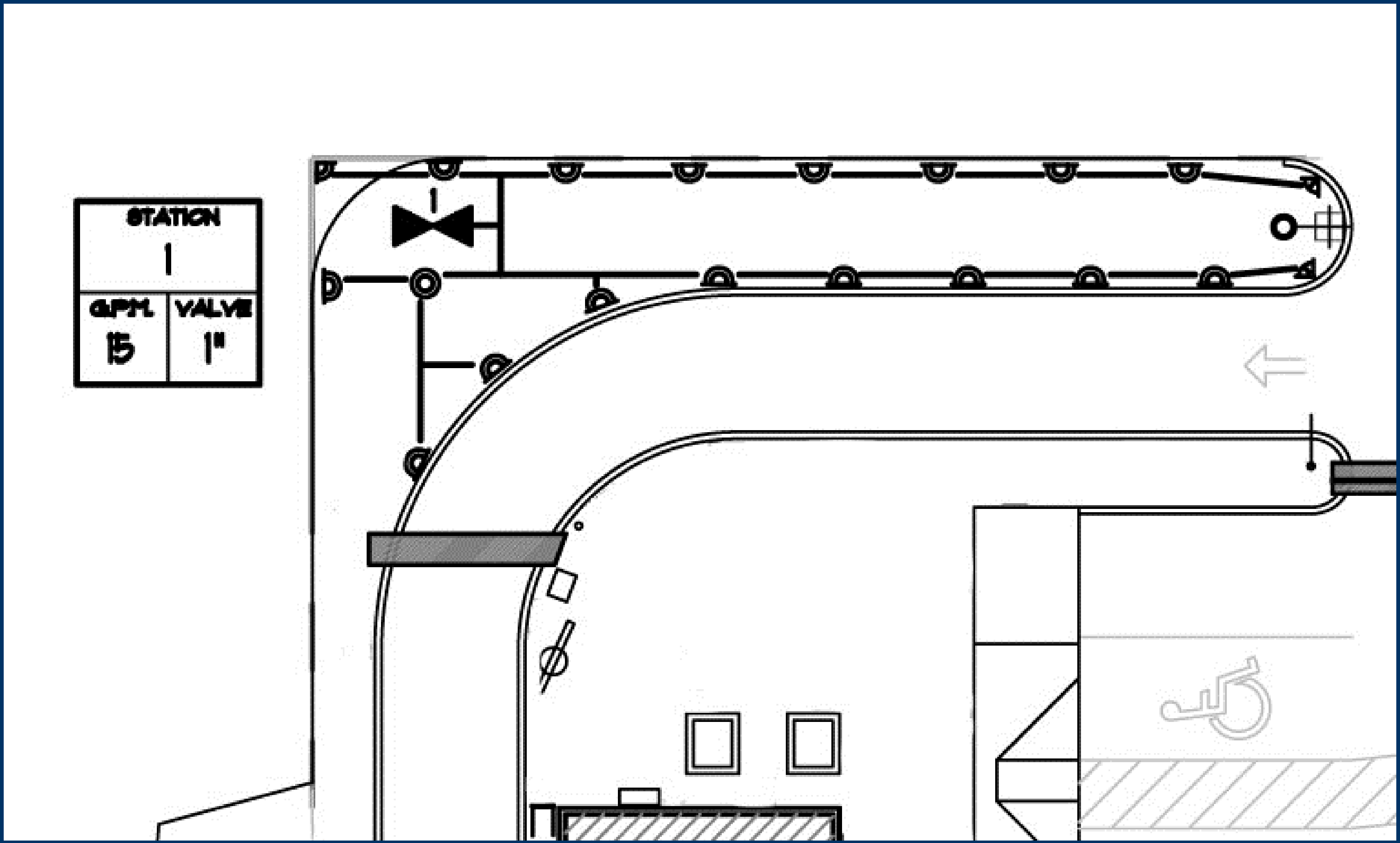
Head Layout


TRASH ENCLOSURE
ALLEY
FREEZER
STORAGE
TYLER
M
STARBUCKS
EXISTING
RESTAURANT
WISHKAH

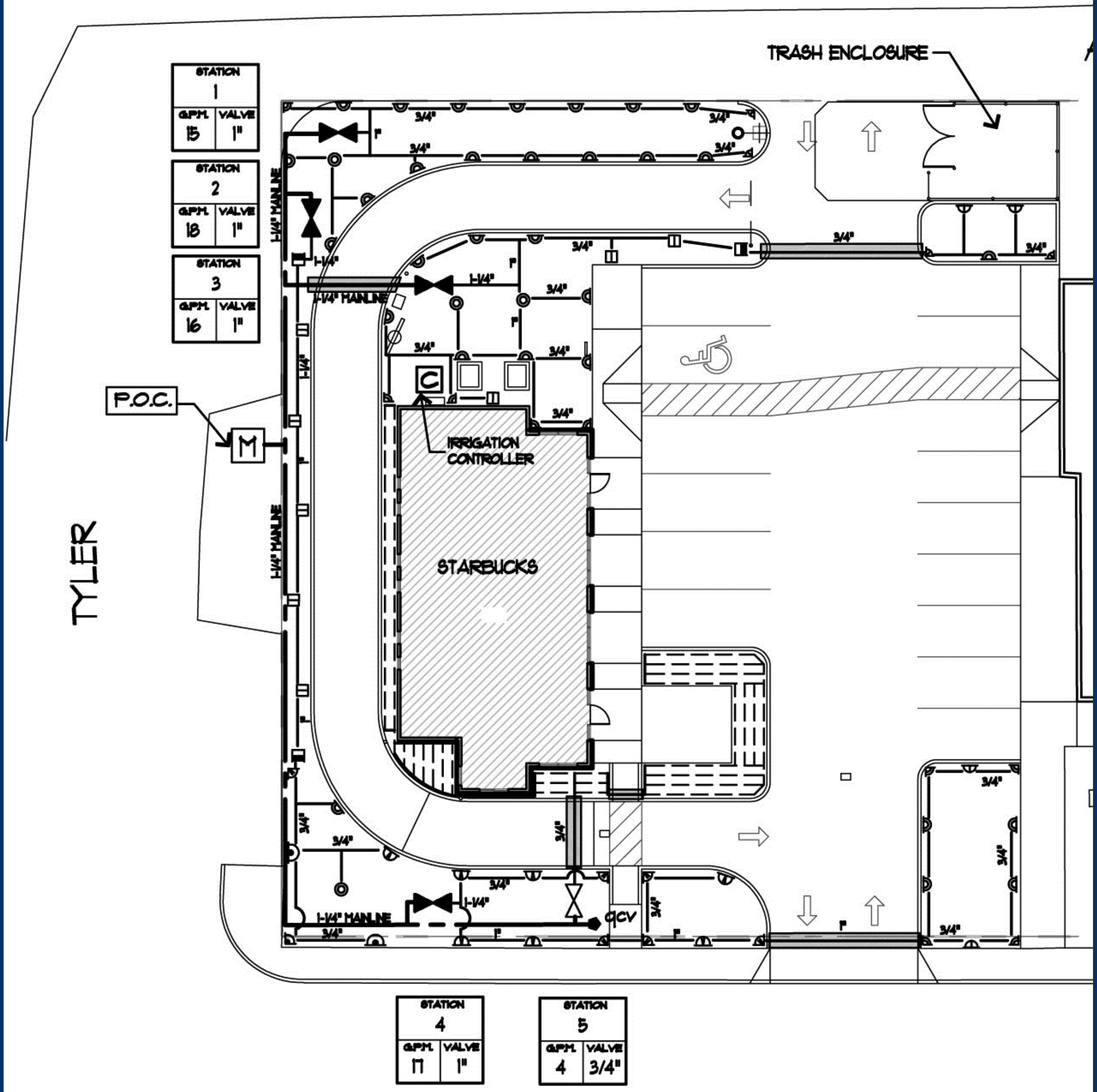
Valves, Types, and Sizing

- Valve types
- Valve sizes (gpm cap)
- Valve location (on plan and in field)
- Station numbering

Zone 1



Lateral layout



STATION 1
G.P.M. 15
VALVE 1"
STATION 2
G.P.M. 18
VALVE 1"
STATION 3
G.P.M. 16
VALVE 1"
TRASH ENCLOSURE
P.O.C.
M
TYLER
1-1/4" MAINLINE
1-1/4"
3/4"
1"
C
IRRIGATION CONTROLLER
STARBUCKS
QCV
STATION 4
G.P.M. 17
VALVE 1"
STATION 5
G.P.M. 4
VALVE 3/4"

Irrigation Demand & Water Budget

How do we determine water needs for site?

- Vegetation type
- Soil type
- Irrigated area
- Evapotranspiration rate
- Irrigation efficiency

Water Budget Calculations

- Required in California and other arid locations
- City of Bellevue Example

City of Bellevue Water Budget Calculations

W3-12.2 Determining the Landscape's Irrigation Water Budget & Total Estimated Water Use

A. A landscape design's IWB shall be calculated based upon the total square footage of the proposed landscape area, excluding retained native vegetation areas and impervious surfaces, using the following formula:

$$IWB = ET \times AF \times LA \times CF$$

IWB: Irrigation Water Budget allowed.

ET: Evapotranspiration Rate of 14.49 inches (per irrigation season, see Section W3-12.3).

AF: Adjustment Factor of 0.8 (0.5/0.625 irrigation efficient).

LA: Landscape Area in square feet.

CF: Conversion Factor of 0.62 (inches to gallons per square foot).

City of Bellevue Water Budget Calculations

Provided Evapotranspiration (ET) Rates

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
.00	.00	.00	.00	1.59	3.13	4.46	3.51	1.77	.03	.00	.00	14.49

Aberdeen Starbucks Water Budget

4351 SF of landscape area

IWB = ET x AF x LA x CF
IWB = 14.49 x 0.8 x 4351 x 0.62

Where
ET = 14.49 in
AF = 0.8
LA = 4351 sf
CF = 0.62

IWB = 31,271 gallons

City of Bellevue Water Budget Calculations

$$EWU = (ET \times PF \times HA \times CF) / IE$$

EWU:	Estimated Water Use (for each hydrozone)
ET:	Evapotranspiration Rate of 14.49 inches (per irrigation season, see Section W3-12.3).
PF:	Plant Factor value for hydrozone (see Section W3-12.4).
HA:	Hydrozone Area in square feet.
CF:	Conversion Factor of 0.62 (inches to gallons per square foot).
IE:	Irrigation Efficiency value for hydrozone (see Section W3-12.5).

Aberdeen Starbucks Water Budget

What is a Hydrozone?

- Planting areas with similar water demands
- Lawns and Turf
- Native areas
- Parking lots
- Shady areas

Aberdeen Starbucks Water Budget

Compile Hydrozones

4351 SF of total landscape area

3 Hydrozones

HZ1 (Street frontage) = 2685 sf
HZ2 (drip area) = 514 sf
HZ3 (north building area) = 1152 sf

Aberdeen Starbucks Water Budget

Hydrozone 1 Calculations

EWU = (ET x PF x HA x CF) / IE

Where

ET = 14.49 in

PF = ?

HA = 2685 sf

CF = 0.62

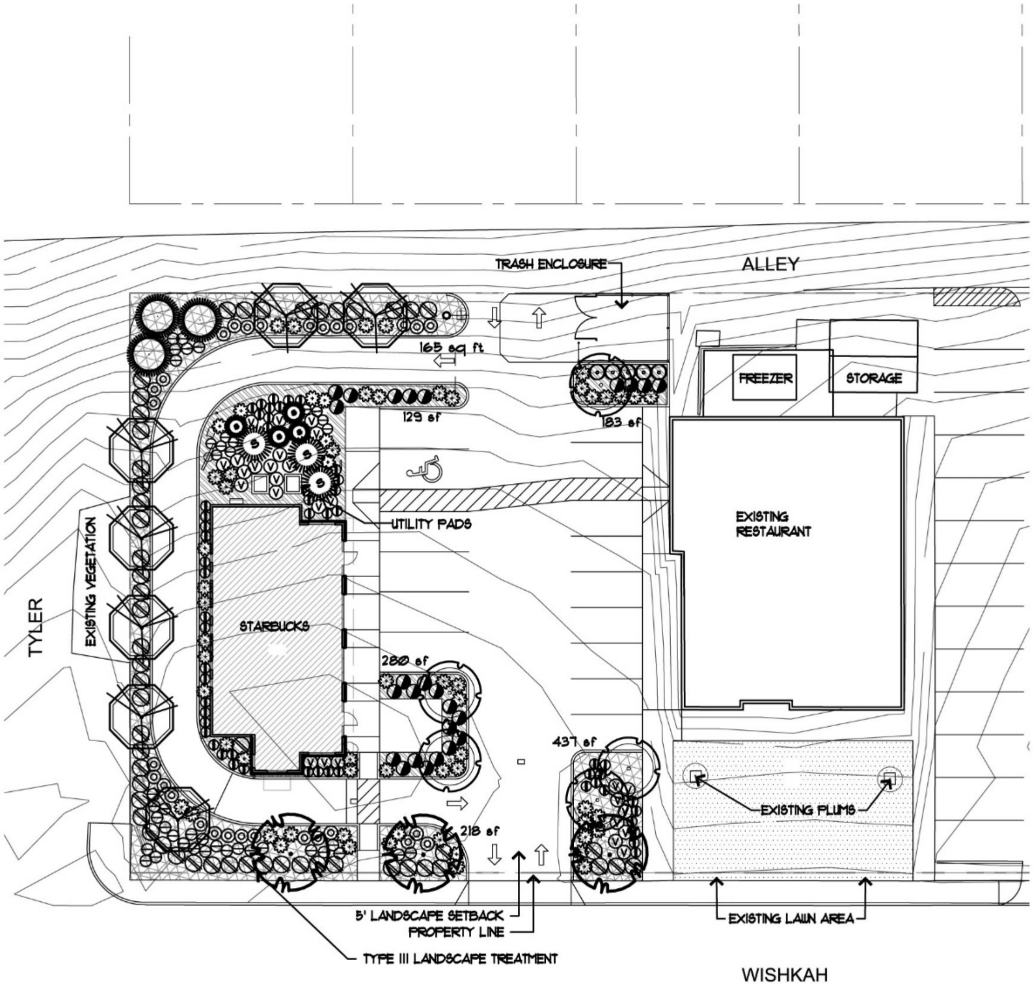
IE = ?

City of Bellevue Water Budget Calculations

BASIC PLANT FACTOR CLASS	PF RANGE
Low water use plants	0.0 to 0.3
Medium water use plants	0.4 to 0.6
High water use plants	0.7 to 1.0
All irrigated turf grass	0.8 to 1.0

Type of Irrigation System Used in Hydrozone	Efficiency Value
Conventional Overhead Spray System: (i.e.: rotors and pop-up spray systems; most commonly used to irrigate turf, but also used in plant beds)	0.625
Low Volume or Drip Irrigation System: (i.e.: micro-spray, bubbler, drip, or other low volume systems which apply water below the ground surface, or directly to the plants root zone; most commonly used	0.925

Landscape Plan



LANDSCAPE PLANT SCHEDULE

DECIDUOUS TREES

KEY	COMMON NAME	BOTANICAL NAME	SIZE & NOTES
	Chanticleer Pear	Pyrus calleryana 'Chanticleer'	1-3/4" Cal., B & B
	Newport Plum	Prunus 'Newport'	1-3/4" Cal., B & B
	Pacific Sunset Maple	Acer pl. 'Warrenred'	1-3/4" Cal., B & B

EVERGREEN TREES

KEY	COMMON NAME	BOTANICAL NAME	SIZE & NOTES
	Omorika Spruce	Picea omorika	B&B, 6' Min. Ht.
	Mountain Hemlock	Tsuga mertensiana	B&B, 4'and 6' Min. Ht.

EVERGREEN SHRUBS

KEY	COMMON NAME	BOTANICAL NAME	SIZE & NOTES
	Dwarf Red-Twig Dogwood	Cornus stolinefera 'Kelsyi'	2 Gal. Cont.
	Emerald green Arborvitae	tsuga occidentalis 'Emerald green'	4' Ht., B & B
	Laurustinus	Viburnum tinus	5 Gal. Cont.
	White Rockrose	Cystus corbariensis 'hybridus'	5 Gal. Cont.
	Dwarf Fountain Grass	Pennisetum orientale 'Hameln'	1 Gal. Cont.
	Midwinter Fire Dogwood	Cornus stolinifera 'Midwinters Fire'	2 Gal. Cont.
	Goldflame Spirea	Spireae 'Goldflame'	2 Gal. Cont.
	David's Viburnum	Viburnum davidii	5 Gal. Cont.

GROUNDCOVERS

KEY	COMMON NAME	BOTANICAL NAME	SIZE & NOTES
	Kinnikinnick	Arctostaphylus uva-ursa	1 Gal. Cont, 24" O.C.
	Taiwan Bramble	Rubus pentalobis	1 Gal. Cont, 24" O.C.

EXISTING VEGETATION

KEY	COMMON NAME	BOTANICAL NAME	SIZE & NOTES
	Plum Tree		
	Lawn Area		

Aberdeen Starbucks Water Budget

Hydrozone 1 Calculations

EWU = (ET x PF x HA x CF) / IE
EWU = (14.49 x 0.6 x 2685 x 0.62) / 0.625

Where
ET = 14.49 in
PF = 0.6
HA = 2685 sf
CF = 0.62
IE = 0.625

EWU (HZ1) = 23,157 gallons

Aberdeen Starbucks Water Budget

Run Hydrozone 2 and Hydrozone 3 Calculations to get Site EWU.

HZ2 (drip area) = 514 sf
HZ3 (north building area) = 1152 sf

EWU = (ET x PF x HA x CF) / IE

Site EWU = EWU1 (23,157) + EWU2 + EWU3

Site EWU must be less than IWB of 31,271 gallons

Drip irrigation benefits and types

- Extremely efficient
- Low precipitation rates
- Commercial & Residential Grades
- Dripline and Drip tube

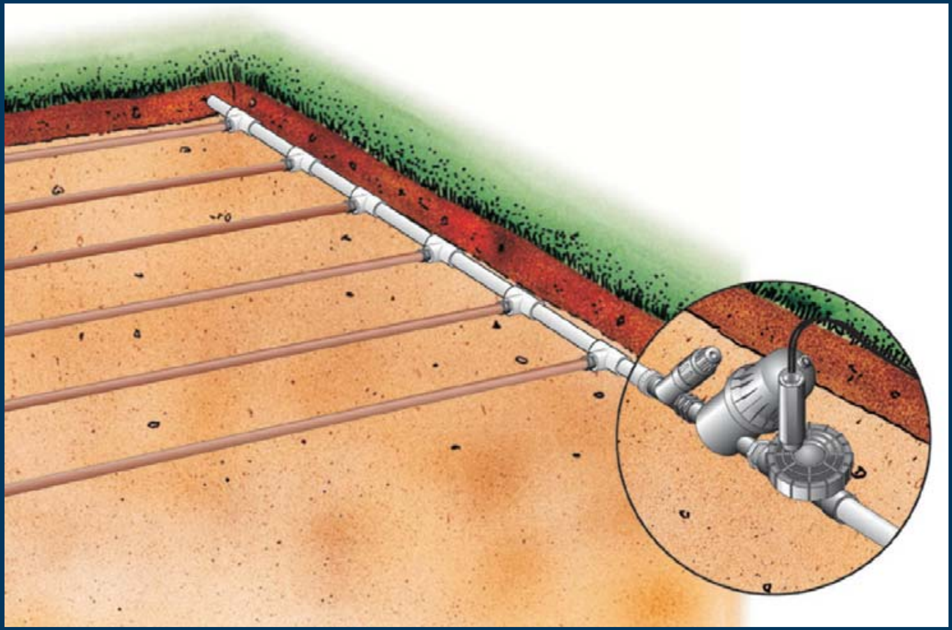
Drip irrigation challenges

- Commercial applications – dripline tubing
- Exposed tubing, tripping hazard
- Leak detection, difficult to spot puncture
- Monitoring and Maintenance

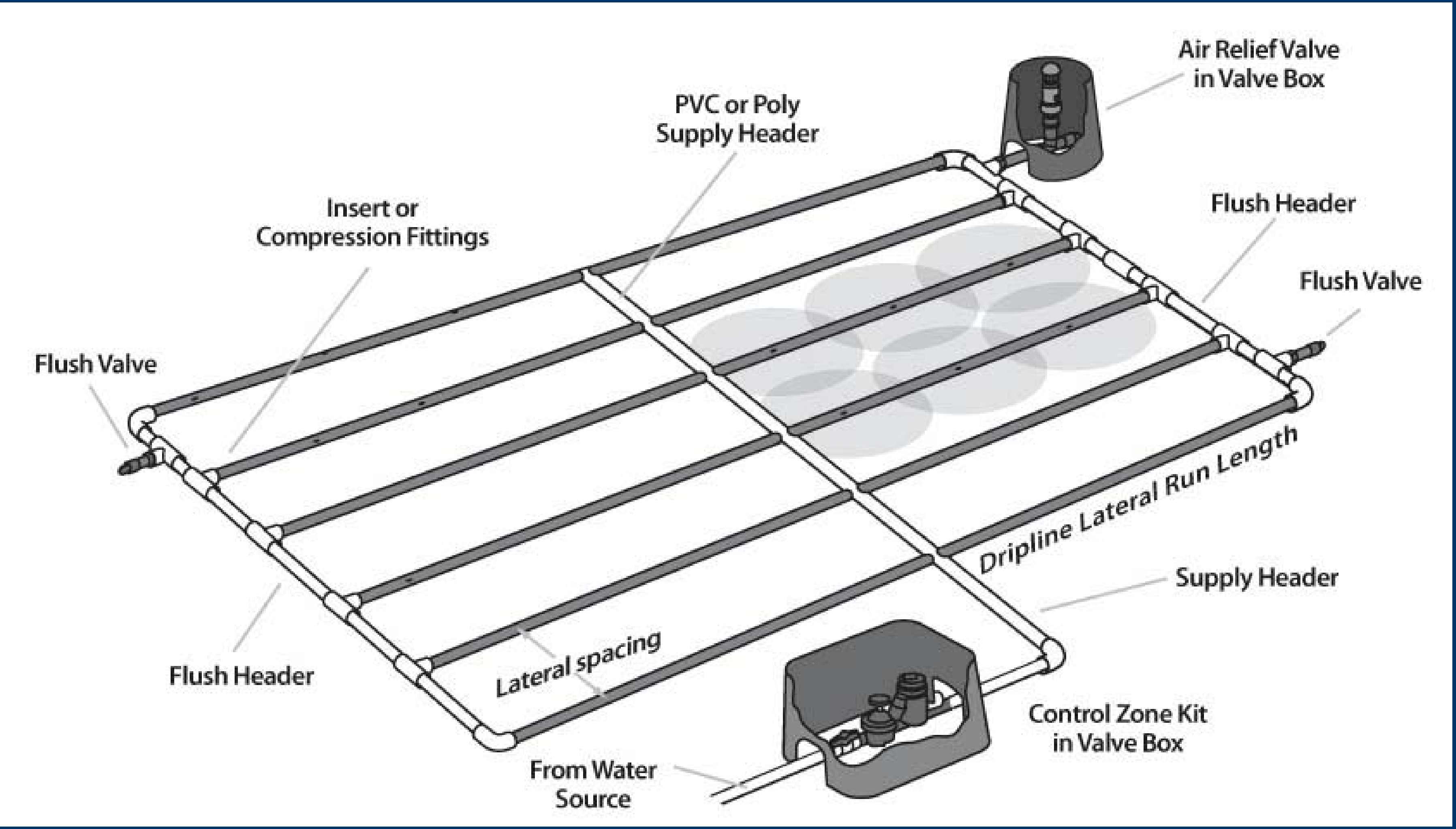
Drip Irrigation

Dripline with Emitters

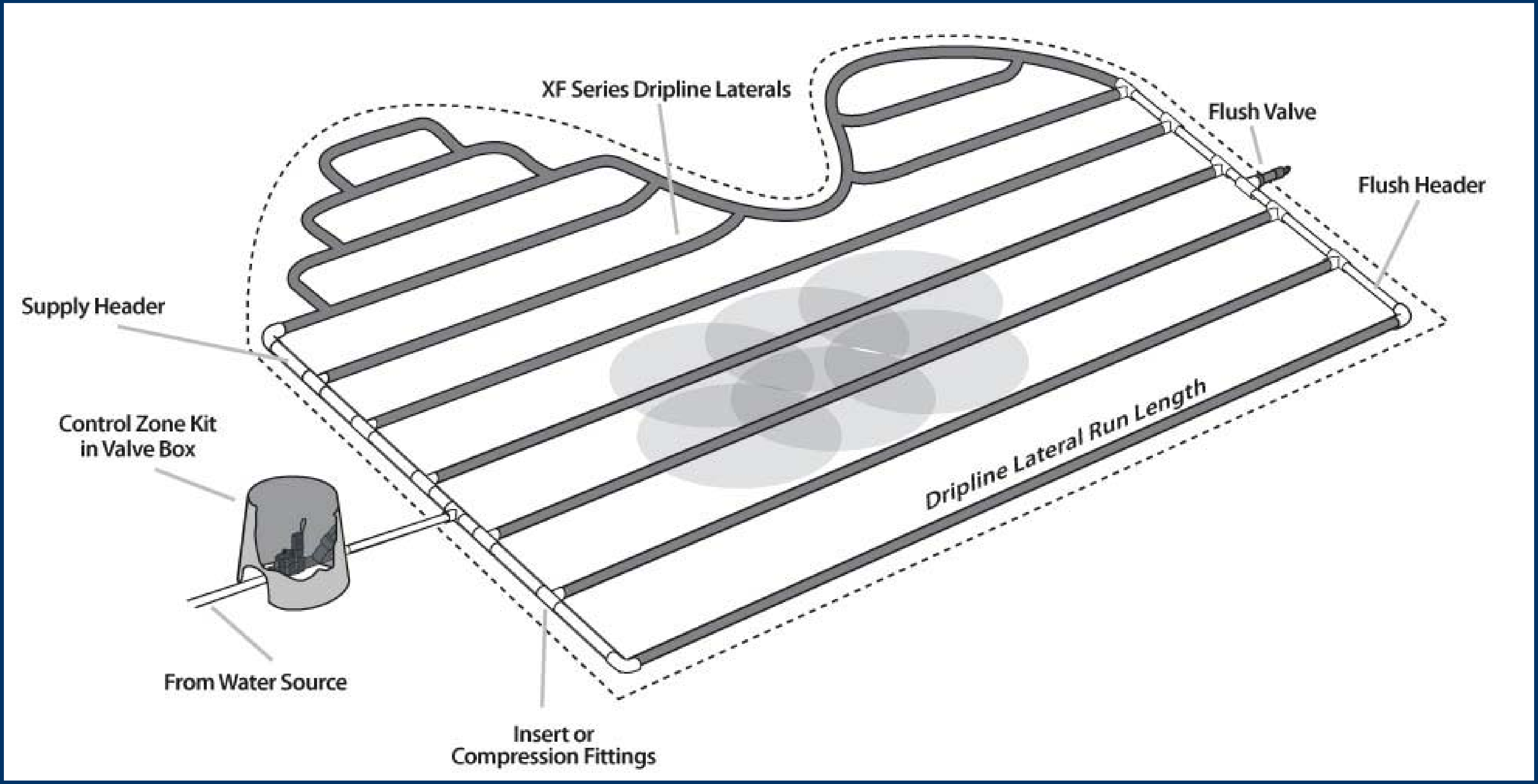
- Irrigates at the source
- Extremely efficient
- Low precipitation rates



Dripline Layout



Dripline Layout



Dripline Selection

TABLE 5: APPLICATION RATE

Emitter Spacing	Lateral Row Spacing (in Inches)										
	12″	13″	14″	15″	16″	17″	18″	19″	20″	22″	24″
0.6 GPH Emitter Flow (Inches per hour)											
12″	0.96	0.89	0.83	0.77	0.72	0.68	0.64	0.61	0.58	0.53	0.48
18″	0.64	0.59	0.55	0.51	0.48	0.45	0.43	0.4	0.39	0.35	0.32
24″	0.48	0.44	0.41	0.39	0.36	0.34	0.32	0.3	0.29	0.26	0.24
0.9 GPH Emitter Flow (Inches per hour)											
12″	1.44	1.33	1.24	1.16	1.08	1.02	0.96	0.91	0.87	0.79	0.72
18″	0.96	0.89	0.83	0.77	0.72	0.68	0.64	0.61	0.58	0.53	0.48
24″	0.72	0.67	0.62	0.58	0.54	0.51	0.48	0.46	0.43	0.39	0.36

Dripline Selection

TABLE 1: OVERALL DESIGN PLAN FOR THE SITE

Soil Infiltration Rates in Inches per Hour			
Percent of Slope	Clay	Loam	Sand
0% - 4%	0.13 - 0.44	0.44 - 0.88	0.88 - 1.25
5% - 8%	0.1 - 0.35	0.35 - 0.7	0.7 - 1

Soil Infiltration Rates in CM per Hour			
Percent of Slope	Clay	Loam	Sand
0% - 4%	0.33 - 1.12	1.12 - 2.24	2.24 - 3.18
5% - 8%	0.25 - 0.89	0.89 - 1.78	1.78 - 2.54

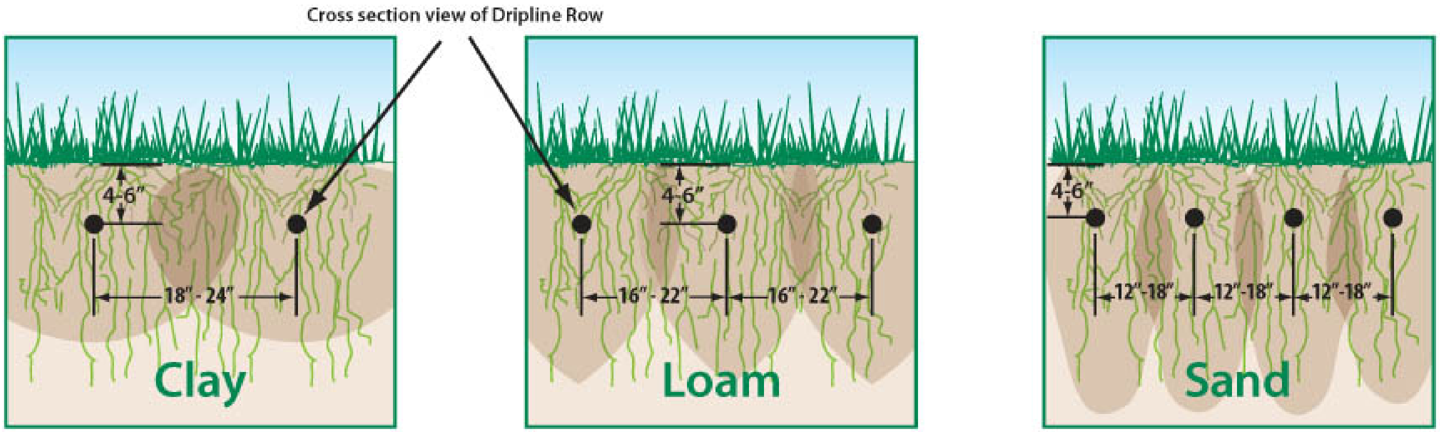
Note: As the slope increases, infiltration rates will continue to decrease. These values are derived from USDA information.

DETERMINE SOIL TYPE

WHAT IS YOUR SOIL TYPE?

The objective of a well-designed dripline system is to create an even wetting pattern of water in the soil throughout the planting zone. There are four factors to consider for planting areas to create an even wetting pattern:

- Soil type (Clay, Loam, Sand)
- Emitter flow rate (0.6 GPH or 0.9 GPH / 2.3 l/hr or 3.4 l/hr)
- Emitter spacing (12", 18" or 24" / 0.30m, 0.45m or 0.61m)
- Lateral spacing (distance between the dripline rows)



These illustrations show water movement in a sub-surface application. These guidelines apply to on-surface as well as sub-surface installations.

Dripline Selection

TECHLINE® CV General Guidelines

TABLE 1

	TURF			SHRUB and GROUND COVER		
	Clay Soil	Loam Soil	Sandy Soil	Clay Soil	Loam Soil	Sandy Soil
Dripper Flow	0.26 GPH	0.4 GPH	0.6 GPH	0.26 GPH	0.4 GPH	0.6 GPH
Dripper Interval	18"	12"	12"	18"	18"	12"
Lateral (Row) Spacings	18" - 22"	18" - 22"	12" - 16"	18" - 24"	18" - 24"	16" - 20"
Burial Depth	Bury evenly throughout the zone 4" to 6"			On-surface or bury evenly throughout the zone to a maximum of 6 inches		
Application Rate (in./hr.)	.19 - .15	.43 - .35	.96 - .72	.19 - .14	.29 - .21	.72 - .58
Time to Apply 1/4" of Water (in minutes)	79 - 100	35 - 43	16 - 21	79 - 107	52 - 71	21 - 26

Maximum spacing recommendations: Following these spacing guidelines, dripper flow selection can be increased if desired by the designer.

Dripline Selection

TABLE 3: CALCULATING ZONE WATER REQUIREMENTS

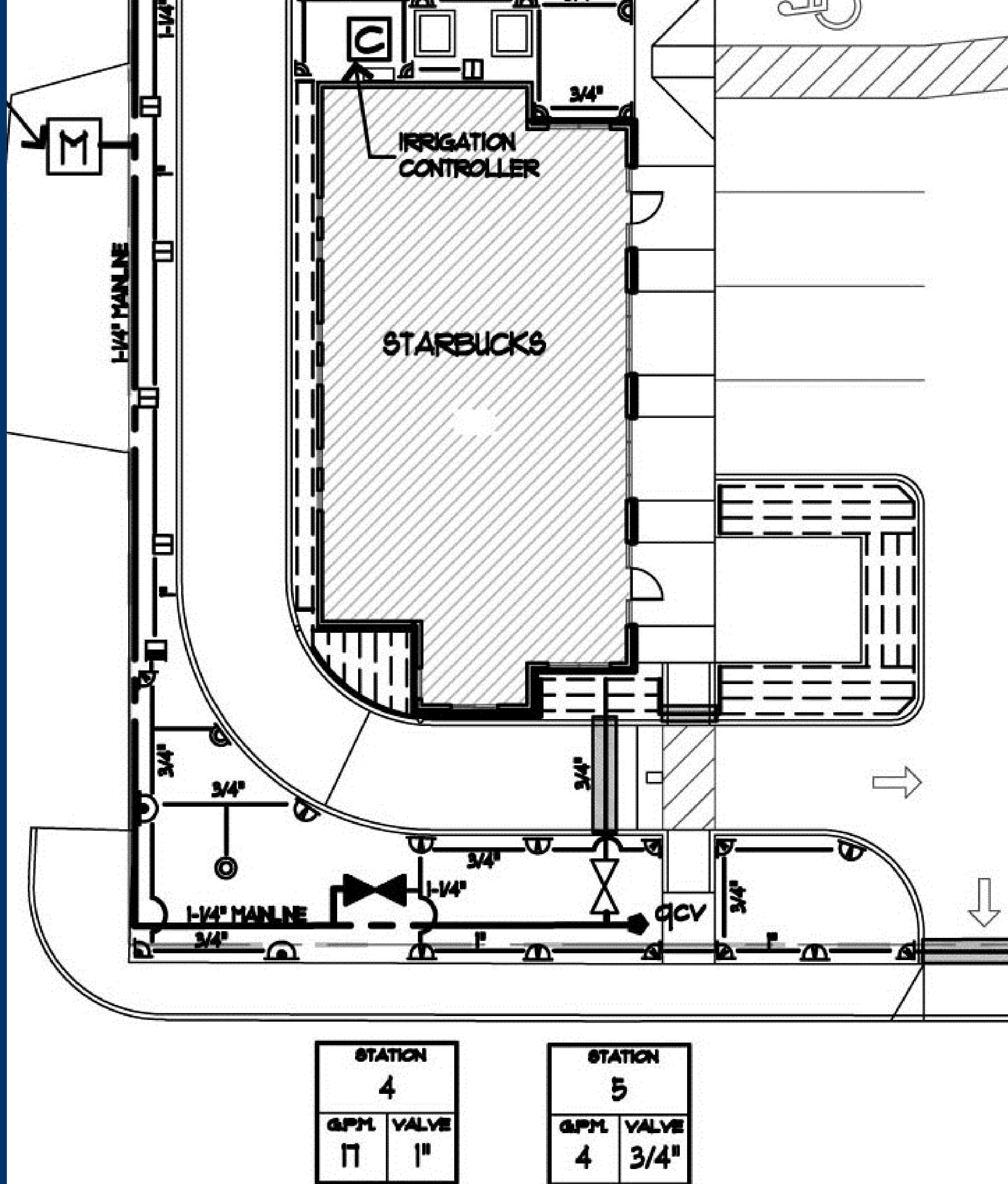
XF Series Dripline Flow (per 100 feet)				
Emitter Spacing	0.6 GPH Emitter		0.9 GPH Emitter	
Inches	GPH	GPM	GPH	GPM
12″	61.00	1.02	92.00	1.53
18″	41.00	0.68	61.00	1.02
24″	31.00	0.52	46.00	0.77

XF Series Dripline Flow (per 100 Meters)				
Emitter Spacing	2.31 L/Hr		3.41 L/Hr	
Meters	L/Hr	L/Min	L/Hr	L/Min
0.30	757.9	12.6	1136.7	18.94
0.46	502.2	8.37	741.3	12.36
0.61	378.7	6.31	559.0	9.32

Dripline Valve Kits

Flow Range	0.2 GPM to 5.0 GPM		3.0 GPM to 15 .0 GPM
Filter Type	**Pressure Regulating Manual Flush**		**Pressure Regulating Manual Flush**
			
Model #	**XCZ-075-PRF**	**XCZ-LF-100-PRF**	**XCZ-100-PRF**
	XACZ-075-PRF (Anti-Siphon)		**XACZ-100-PRF (Anti-Siphon)**
Valve	Low Flow or Anti-Siphon	Low Flow	DV or Anti-Siphon
Inlet x Outlet Size	3/4" FPT x 3/4" MPT	1" FPT x 3/4" MPT	1" FPT x 1" MPT
Inlet Pressure	20 to 120 PSI (1.38 to 8.28 bar)		20 to 120 PSI (1.38 to 8.28 bar)
Regulating Pressure	30 PSI (2 bar)		40 PSI (2.7 bar)
Filter	200 Mesh Stainless Steel (75 micron)		200 Mesh Stainless Steel (75 micron)
Replacement Filter	RBY200SSMX		RBY200SSMX

Dripline Valve Kits


C
M
IRRIGATION CONTROLLER
STARBUCKS
1-1/4" MAINLINE
1-1/4"
3/4"
1"
QCV
STATION 4
G.P.M. 17
VALVE 1"
STATION 5
G.P.M. 4
VALVE 3/4"

DRIP IRRIGATION INFORMATION

1. IRRIGATION CONTRACTOR SHALL ADHERE TO MANUFACTURER SPECIFICATIONS REGARDING DESIGN AND INSTALLATION OF THE DRIP IRRIGATION SYSTEM.

2. ADJUST DRIPPER SPACING FOR INDIVIDUAL PLANTING REQUIREMENTS.

3. PRODUCT TO BE RAINBIRD LANDSCAPE DRIPLINE OR EQUAL.

4. OPERATING PRESSURE RANGE 8 TO 60 PSI. SYSTEM DESIGNED FOR 35 PSI

DRIP IRRIGATION ZONE INFORMATION

1. DRIP LINE SPACING 18"

2. EMITTER SPACING 18"

3. EMITTER DISCHARGE 0.6 GPH

4. DRIPLINE TO BE RAINBIRD LD-06-18-500

5. MAXIMUM LATERAL LENTGH TO BE 435 FT AT 35 PSI.

6. VALVE TO BE RAINBIRD CONTROL ZONE KIT XACZ-075.

Drip Zone Calculations

Get total length of dripline in zone
385 ft at Aberdeen site

Divide by emitter spacing to get # of emitters
385' / 1.5' = 257

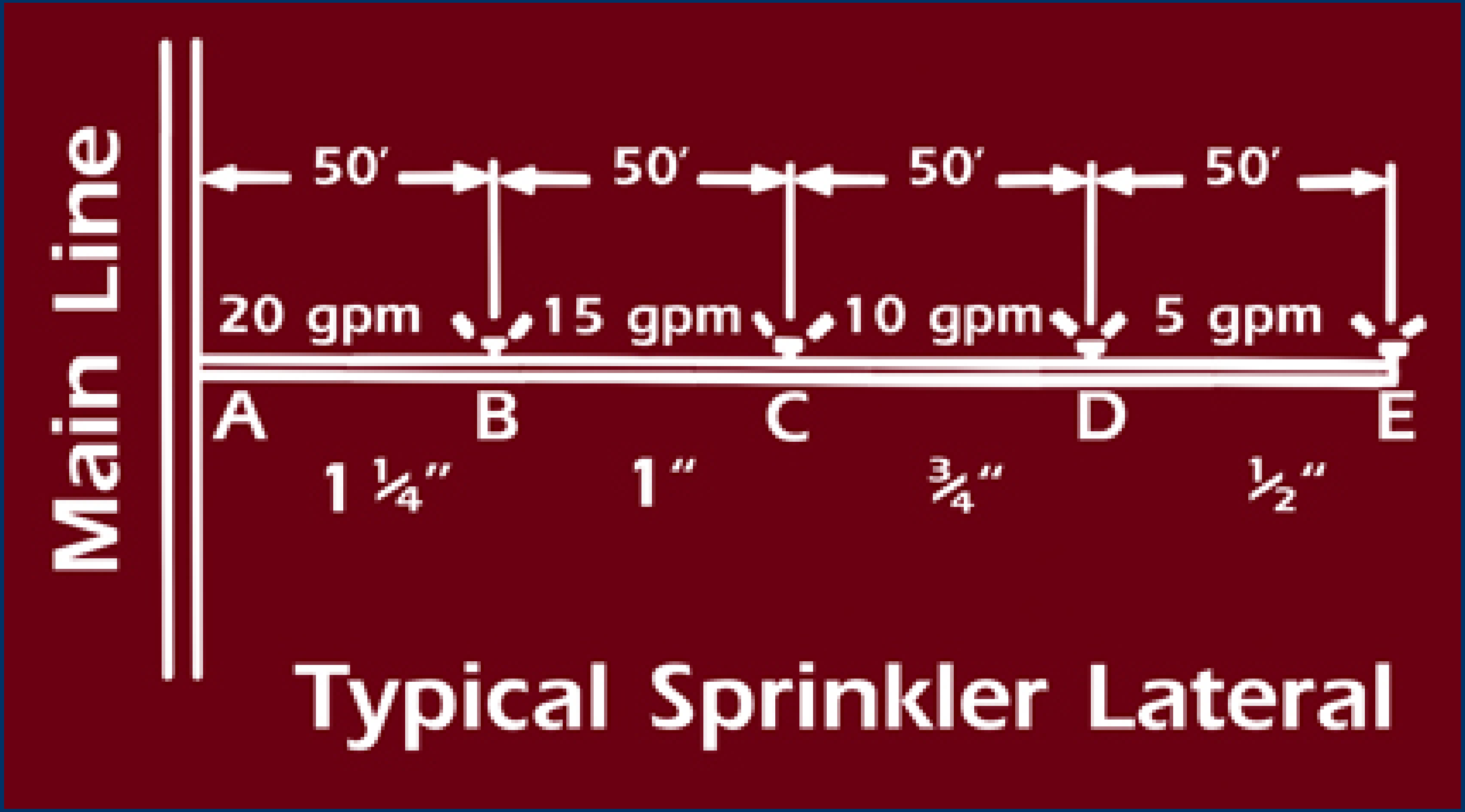
Multiply # of emitters by dripline GPH
257 * .6 gph = 154.2 zone gph

Divide total by 60 to convert to minutes
154.2 / 60 = **2.57 gpm**

Pipe Sizing & Worst Case Zone

- Showing pipe sizes for proper system function
- 5 feet per second rule
- Friction loss charts are our friends!
- Adjust pipe sizes as necessary to minimize cost
- Run pressure loss calculations on your worst zone

Pipe Sizing Example



Pipe Sizing Example

Each Head is 5 GPM

Static pressure is 60 psi

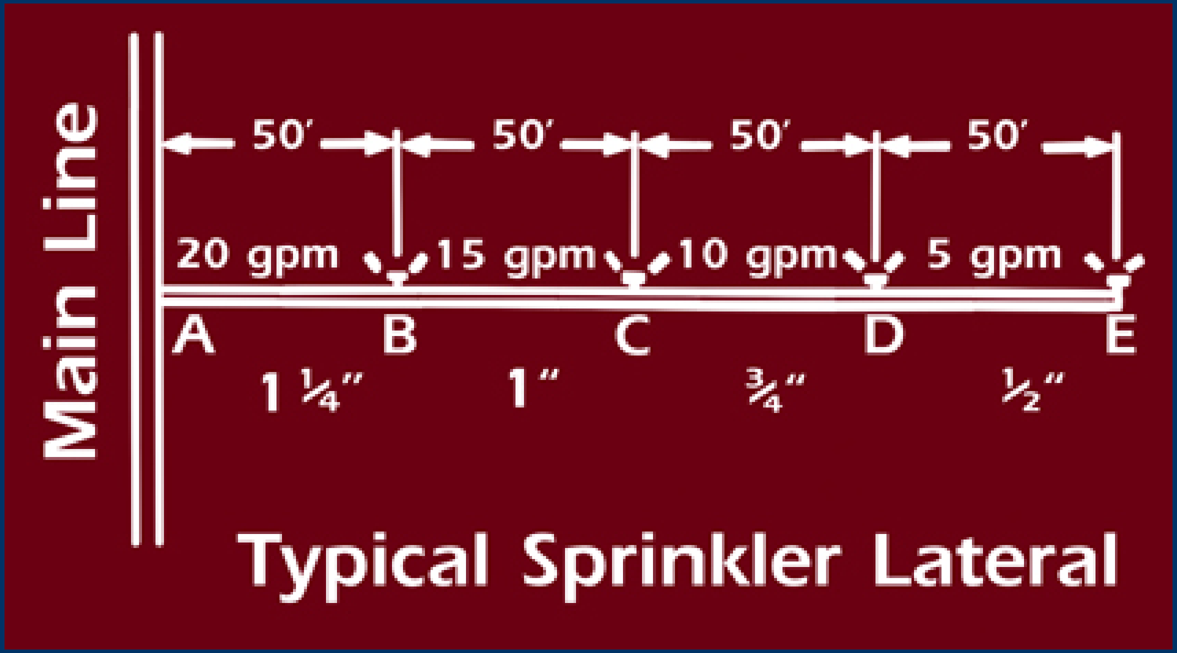
Need 50 psi at each head to function

50’ spacing and lateral length

Use 5 FPS rule and size each lateral section

Start at mainline and work out

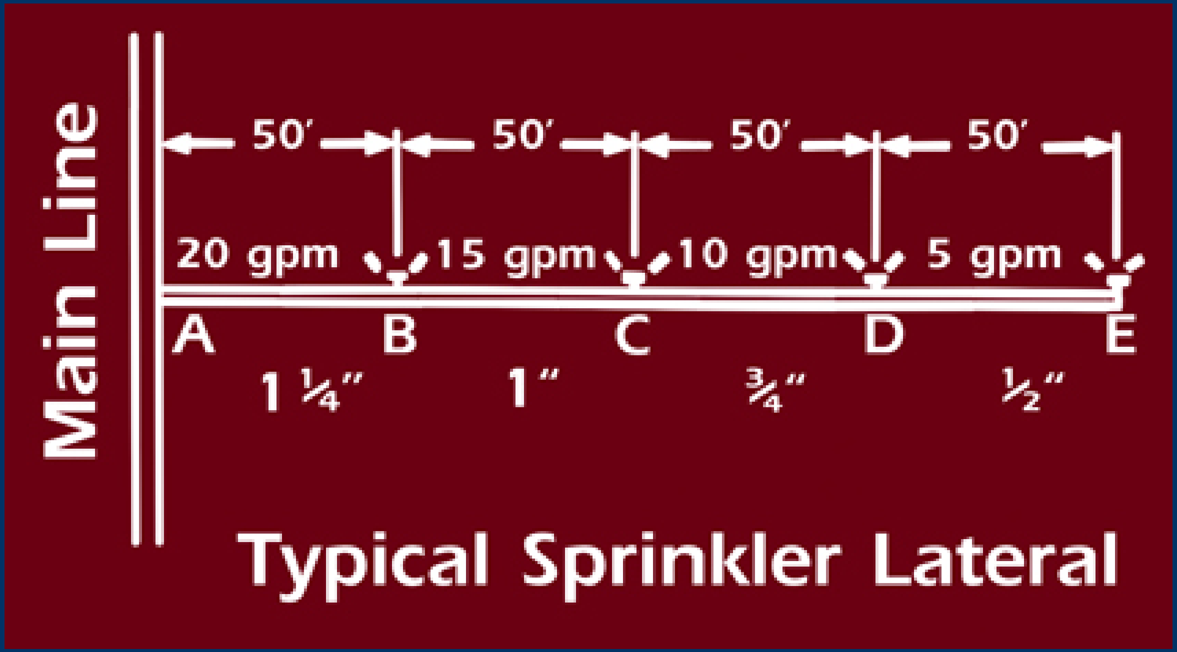
Pipe Sizing Example



20 GPM flow for first lateral section

Friction loss chart shows 1-1/4” meets 5 FPS rule

Friction loss is 1.51 psi per 100 ft



15 GPM flow for first second lateral section

Friction loss chart shows 1” meets 5 FPS rule

Friction loss is 3.11 psi per 100 ft

Now at 57.74 psi

Pipe Sizing Example

PIPE SIZING CHART					
Maximum Flow Rates for Sprinkler Lines					
PVC Schedule 40		PVC Class 200		Polyethylene Pipe	
3/4"	8 GPM	3/4"	10 GPM	3/4"	8 GPM
1"	13 GPM	1"	16 GPM	1"	13 GPM
1 1/4"	22 GPM	1 1/4"	26 GPM	1 1/4"	22 GPM

Worst Case Zone

- Find valve with highest GPM
- Find valve farthest away from water source
- Calculate friction loss to the last head on zone
- Include pressure demand at head
- Compare to available pressure
- Does it work?

Irrigation Controllers

- Selecting a Controller
- Locating the Controller
- Power & Wiring Requirements
- Central Controls
- Water Conservation Features
  - Cycle & Soak
  - ET based
  - Rain shut off device

Irrigation Controllers

Irrigation Controllers

Irrigation Controllers

Locating the Controller on the Plan / Site

- Power Requirements
- Maintenance and Access
- Wire Routing and Distance
- Inside / Outside
- Client Preference

Irrigation Controllers

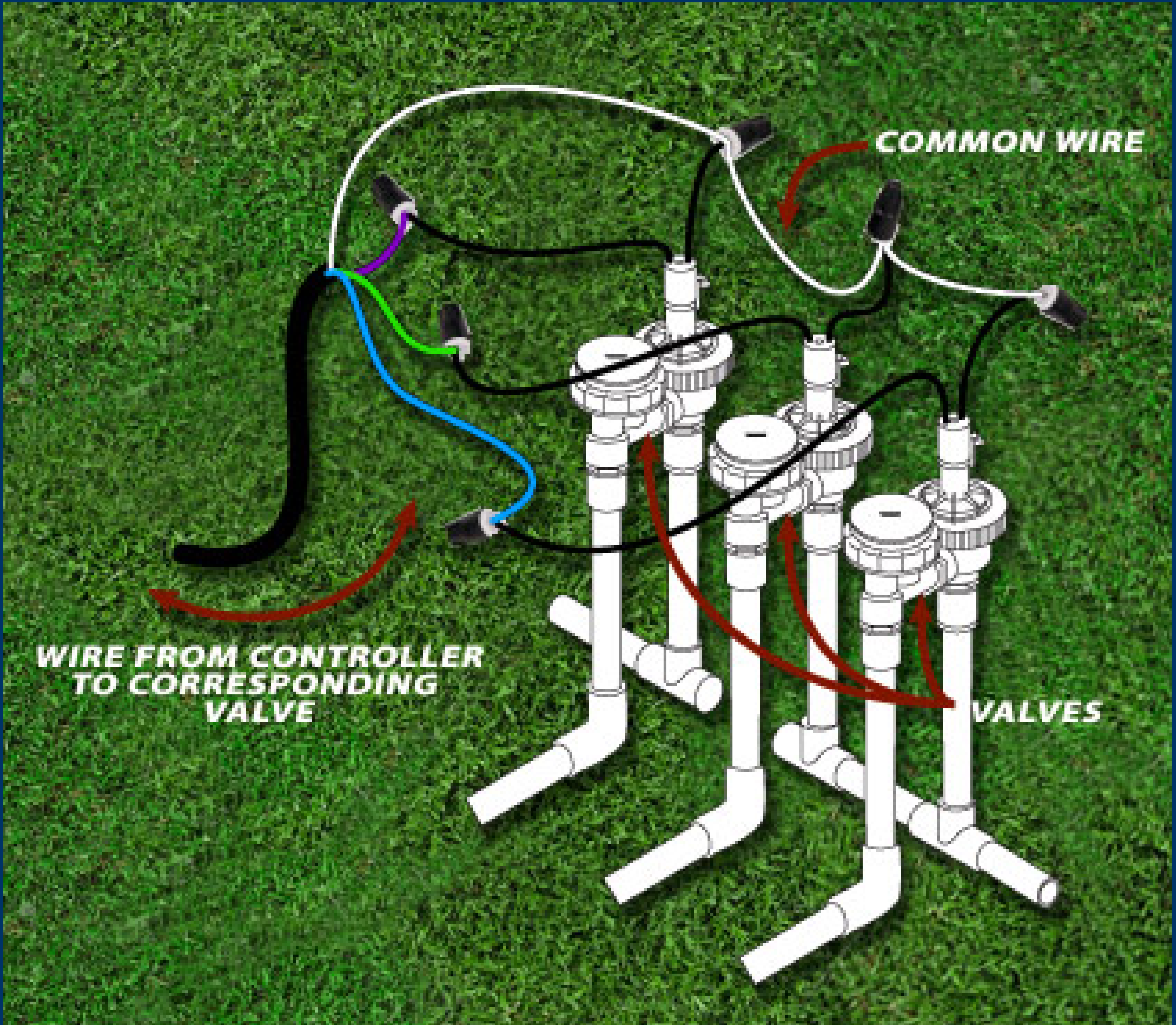
Wiring Types and Sizes

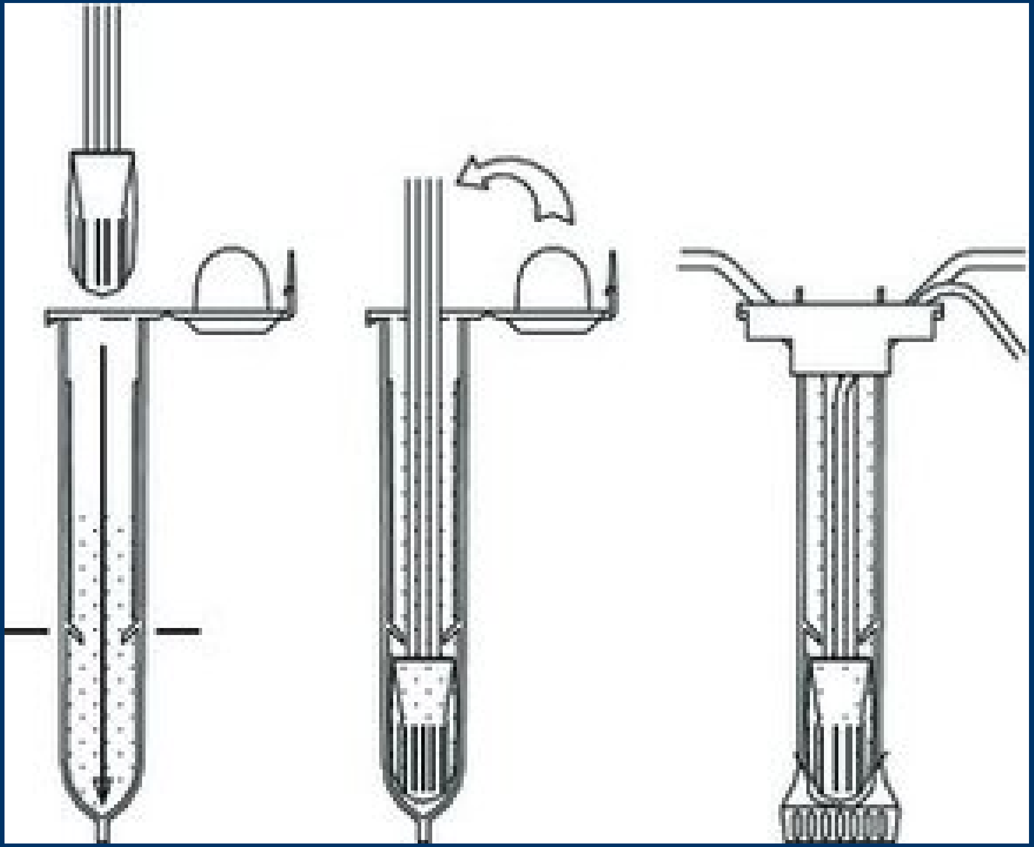
- Wire gauge & distances
- Connections & Splicing
- Wire Routing and Distance

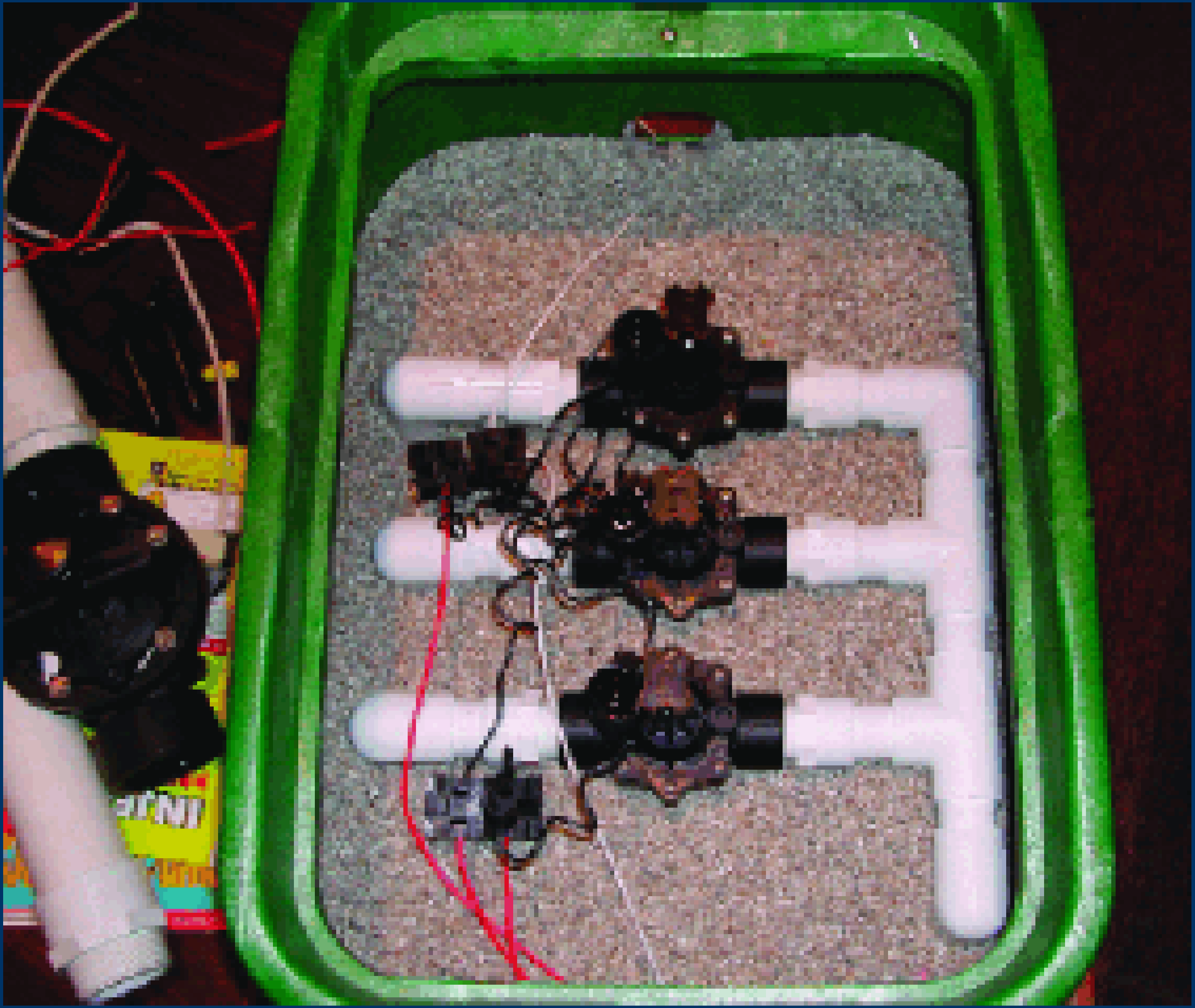
Wires come in different sizes. The maximum current each size can conduct safely is shown.

Wire Sizing

Wire and Cable Gauge	Amps	Max Wattage Load	Uses
14-gauge	15 amps	1440 watts (120 volts)	Common residential wiring: Light fixtures, receptacles
12-gauge	20 amps	1920 watts (120 volts) 3840 watts (240 volts)	Common residential wiring: Light fixtures, receptacles, small appli-ances like a microwave
10-gauge	30 amps	2880 watts (120 volts) 5760 watts (240 volts)	Large appliances: Window a/c unit, clothes dryer
8-gauge	40 amps	7680 watts (240 volts)	Large appliances: Electric range, central a/c
6-gauge	50 amps	9600 watts (240 volts)	Large appliances: Central a/c, electric furnace


COMMON WIRE
WIRE FROM CONTROLLER
TO CORRESPONDING
VALVE
VALVES



Finalizing a Design

- Legend & Notes
- Construction Details
- Re-visit code requirements
- Specifications

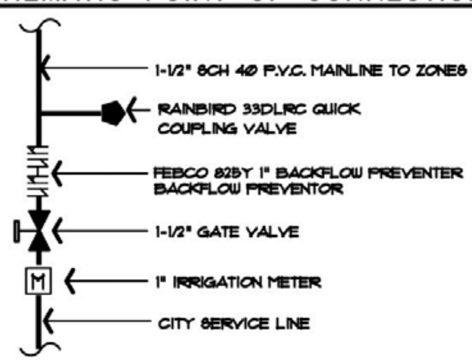
IRRIGATION LEGEND

- RAINBIRD DRIP IRRIGATION VALVE (CONTROL ZONE KIT - SEE NOTES BELOW)
- RAINBIRD PEB-PRS-B SERIES VALVE (SIZE AS NOTED)
- CLASS 200 P.V.C. LATERALS
- SCH 40 P.V.C. 2" MAINLINE
- RAINBIRD LANDSCAPE DRIPLINE (SEE NOTES L2-2)
- C — RAINBIRD ESP-MC-8 AUTOMATIC CLOCK/ CONTROLLER WALL MOUNT
- RAINBIRD 33 DLRC 3/4" QUICK COUPLING VALVE
- 4" MIN. CLASS 200 PVC SLEEVE
- P.O.C. — POINT OF CONNECTION (SEE SCHEMATIC BELOW)
- M — 1" WATER METER PER CITY STANDARDS

HEAD KEY

- RAINBIRD 1812-SAM 15' RAD HALF CIRCLE (1.85 GPM @ 30 PSI)
- RAINBIRD 1812-SAM 15' RAD QTR CIRCLE (0.92 GPM @ 30 PSI)
- RAINBIRD 1812-SAM 12' RAD HALF CIRCLE (1.30 GPM @ 30 PSI)
- RAINBIRD 1812-SAM 12' RAD HALF CIRCLE (1.30 GPM @ 30 PSI)
- RAINBIRD 1812-SAM 10' RAD FULL CIRCLE (1.58 GPM @ 30 PSI)
- RAINBIRD 1812-SAM 10' RAD 3QTR CIRCLE (1.19 GPM @ 30 PSI)
- RAINBIRD 1812-SAM 10' RAD HALF CIRCLE (0.79 GPM @ 30 PSI)
- RAINBIRD 1812-SAM 10' RAD QTR CIRCLE (0.39 GPM @ 30 PSI)
- RAINBIRD 1812-SAM 8' RAD HALF CIRCLE (0.52 GPM @ 30 PSI)
- RAINBIRD 1812-SAM 8' RAD QTR CIRCLE (0.26 GPM @ 30 PSI)
- RAINBIRD 1812-SAM 4'x30' SIDE STRIP (1.21 GPM @ 30 PSI)
- RAINBIRD 1812-SAM 4'x15' END STRIP (0.61 GPM @ 30 PSI)

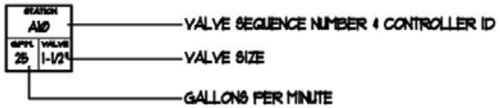
SCHEMATIC POINT OF CONNECTION



GENERAL NOTES

1. ALL SHRUB AREA POP-UP SPRAY HEADS TO BE 6" HEIGHT.
2. ALL PIPING IS DIAGRAMATIC IN NATURE PIPES TO SHARE TRENCHES WHERE POSSIBLE. SEPARATE COMMON PIPING BY 6" MIN.
3. ADJUST SPRAY PATTERN FOR MAXIMUM COVERAGE AND MINIMUM OVERSPRAY.
4. IRRIGATION CONTRACTOR TO PROVIDE IRRIGATION CLOCK/CONTROLLER. (VERIFY LOCATION PRIOR TO BEGINNING WORK)
5. GENERAL CONTRACTOR TO PROVIDE AND INSTALL ALL CONDUIT TO CLOCK LOCATION.
6. GENERAL CONTRACTOR TO PROVIDE POWER SOURCE FOR CLOCK. (VERIFY LOCATION PRIOR TO BEGINNING WORK)
7. IRRIGATION CONTRACTOR TO PROVIDE AND INSTALL ALL RREQUIRED PLUMBING SLEEVES WHERE NECESSARY.
8. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL PUBLIC AND PRIVATE UTILITIES WITHIN THE PROJECT AREA PRIOR TO CONSTRUCTION. NOTIFY LANDSCAPE ARCHITECT OF ALL DISCREPANCIES.
9. CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE CODES AND APPROPRIATE SAFETY REGULATIONS.

VALVE KEY



DRIP IRRIGATION INFORMATION

1. IRRIGATION CONTRACTOR SHALL ADHERE TO MANUFACTURER SPECIFICATIONS REGARDING DESIGN AND INSTALLATION OF THE DRIP IRRIGATION SYSTEM.
2. ADJUST DRIPPER SPACING FOR INDIVIDUAL PLANTING REQUIREMENTS.
3. PRODUCT TO BE RAINBIRD LANDSCAPE DRIPLINE OR EQUAL.
4. OPERATING PRESSURE RANGE 8 TO 60 PSI. SYSTEM DESIGNED FOR 35 PSI

DRIP IRRIGATION ZONE INFORMATION

1. DRIP LINE SPACING 18"
2. EMITTER SPACING 18"
3. EMITTER DISCHARGE 0.6 GPH
4. DRIPLINE TO BE RAINBIRD LD-06-18-500
5. MAXIMUM LATERAL LENTGH TO BE 435 FT AT 35 PSI.
6. VALVE TO BE RAINBIRD CONTROL ZONE KIT XACZ-075.

Lessons Learned

- Be sure to coordinate
  - Architect, Landscape arch, civil, owner, contractor
- Know when you don't know
- Power and controls, who does it?
- Contractor qualification
- Follow through, stay involved

QUESTIONS ??

End of Session

See you in two weeks!

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