Smart Irrigation Sales

Technical guide to Practical business Changes

That will help your bottom line

11:38 AM

Craig Borland

Customer Resource Specialist

Throwing water into the air in an outdoor environment and predicting where it will fall is far from an exact science. Many factors can influence this, some within our control but many are not.

As one famous irrigation philosopher once said

“If a landscape was like a pool table watering it would be easy”

Green Matters!

Grass Reduces Greenhouse Gas

Grass Is Nature's Air Conditioner

Grass Purifies Water

- Phyto-remediation research

Grass Purifies the Air

- Absorbs particulates, sulfur dioxide, ozone & other atmospheric pollutants

Grass Provides …

- Urban habitat that is a highly productive forage area for birds/small mammals.
- Attractive recreational area. If lawns are removed, will children and pets be forced to play on native shrubs and bark?

Smart Irrigation

- Exactly the right amount of water
- Applied at the correct time
- Only to the targeted area
- With resource efficient results

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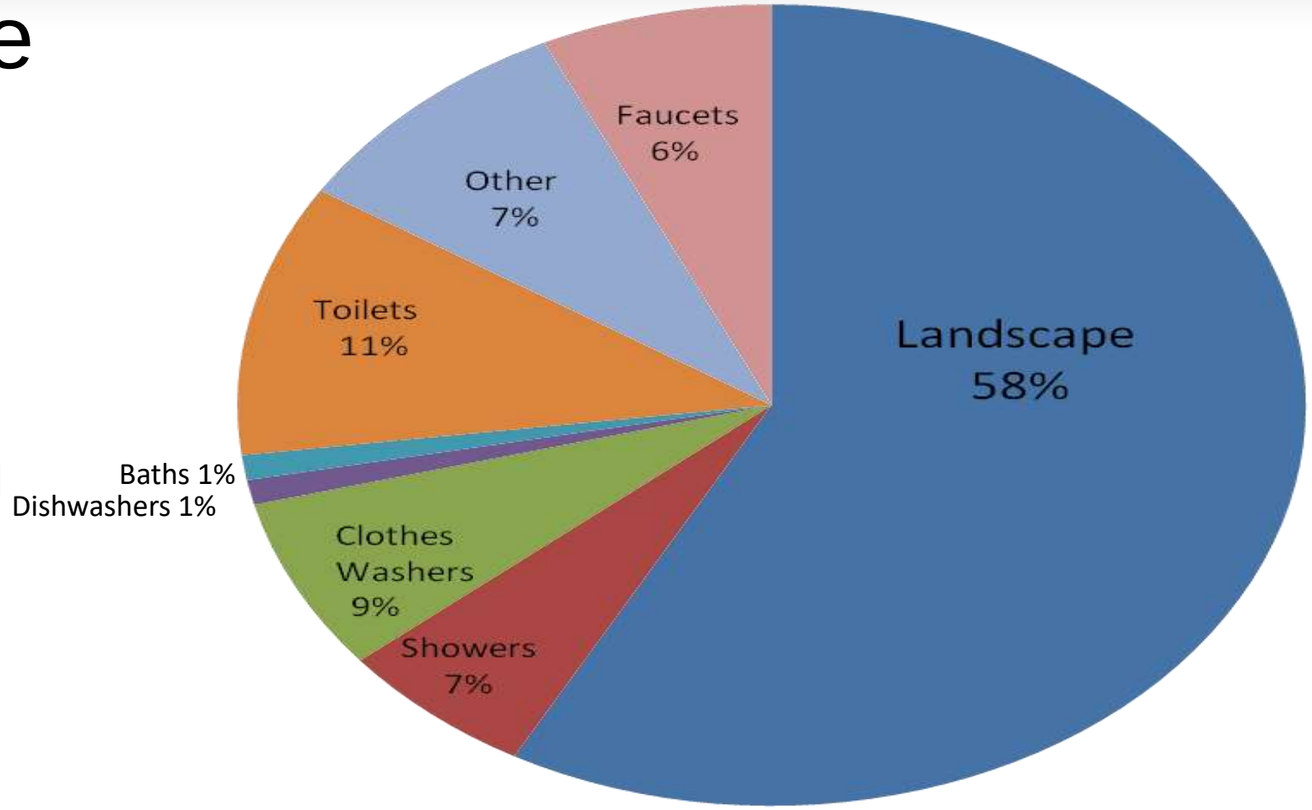
The Regulatory Reality

Lawn care accounts for more than half of outdoor urban water use

Outdoor landscape irrigation 50% Efficient

Lower priority than water use for fire protection, health & safety uses



Smart Irrigation the Products

Identify the Opportunity for Justifiable Investment

- Spray Heads
  - HUGE Installed Base
  - Easy to Update-No Learning Curve
  - Tangible Savings
- Controllers
  - Huge Water Waster
  - No Basis for Schedules

Simple Irrigation Rules

Apply only the water you need

- Scheduling and management

Apply it well

- Design, installation, and maintenance

Designing for Water Conservation

- Water Conservation is the key strategy for long term sustainability of the irrigation industries
- Irrigation designers have an environmental responsibility to protect water resources to the best of their ability through the design process
- Has implications on groundwater runoff, water quality, and resource management
- Requires advanced training and subject knowledge

Coverage Design Principals

- “Did you get it wet?”
- Head to head coverage was perfect
- If coverage was OK, wet and dry spots were “management problems”
- Variance between plant species, hydrozones and microclimates were ignored or downplayed

Irrigation System Problems Are Our Opportunities

1. Sprinkler Spacing
2. Mixed Nozzles and Equipment
3. Plant Interference
4. Incorrect Water Pressure
5. Tilted Sprinkler Heads
6. Head Arc Adjustment
7. Radius Adjustment
8. Low Head Drainage

Higher water costs are finally making it more expensive to waste water than to hire an irrigation professional to upgrade and manage the irrigation system. And rebates help subsidize the cost of the "SMART" hardware.

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Smart Irrigation

What is it

What it is not

- Poor head location
- Mixed Irrigation Products
- Mixed Precipitation Rates
- Misdirected heads

Does not save endless amounts of water

Never designed for “Set-it-and-forget-it”

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Irrigation Hydraulics is:

The study of water behavior

at rest and in motion.

(or in other words--the study of pressure and flow)

Irrigation Hydraulics Affect

- Sprinkler and drip emitter performance
- Uniform application by sprinklers and drip emitters
- Irrigation system cost

Irrigation Hydraulics Affect

- Sprinkler performance
- Uniform coverage
- System cost

Application Rates

- An actual catch-can test is best method to determine the "Application Rate"
- Catalog values are a good starting point
- Conventional spray systems have an application rate of approximately 1.6 inches per hour.
- Most rotary sprinkler systems have an application rate of 0.5 – 0.7 inches per hour.

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Uniformity vs. Efficiency

Uniformity

Refers to how evenly the water is applied to the landscape by the emission devices (sprinklers) comprising an irrigation zone

Efficiency

Refers to how much of the water applied to the landscape is beneficially used by the landscape

Note: For more information see *Understanding the Concepts of Uniformity and Efficiency in Irrigation* at: http://edis.ifas.ufl.edu/AE364 and *Lawn Sprinkler Selection and Layout for Uniform Water Application* at http://edis.ifas.ufl.edu/AE084.

Catch Can Test Parameters

- Record static PSI
- Record operating PSI
- Record wind speed
- Measure sprinkler spacing
- Measure rotor rotation speed (5 rotations)
- Achieve avg catchment = 25 ml
- 24 Catchments (add in increments of 4)

Date	Auditor	Site

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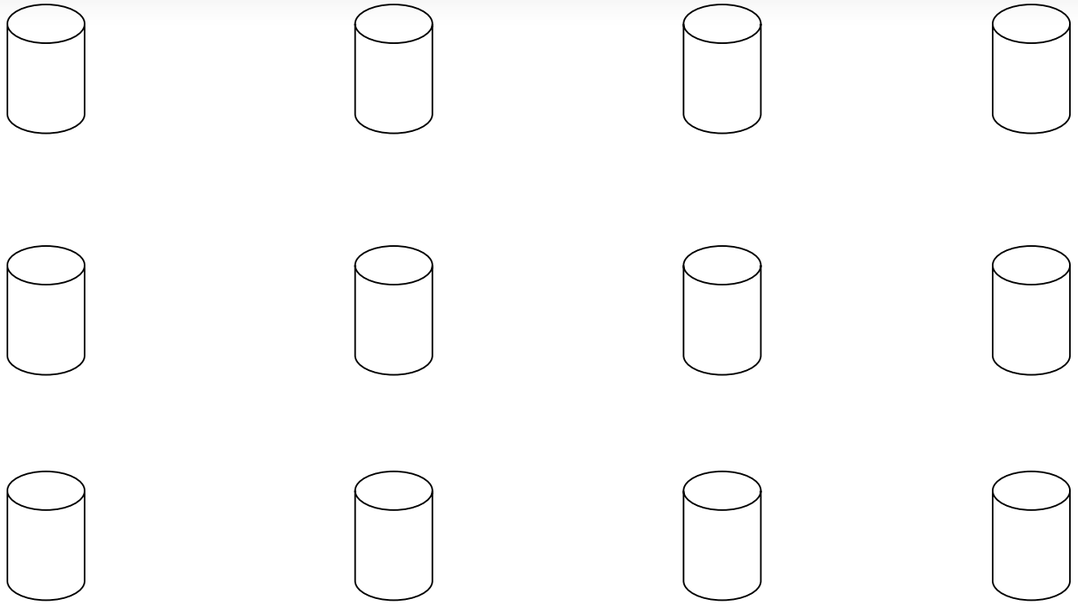
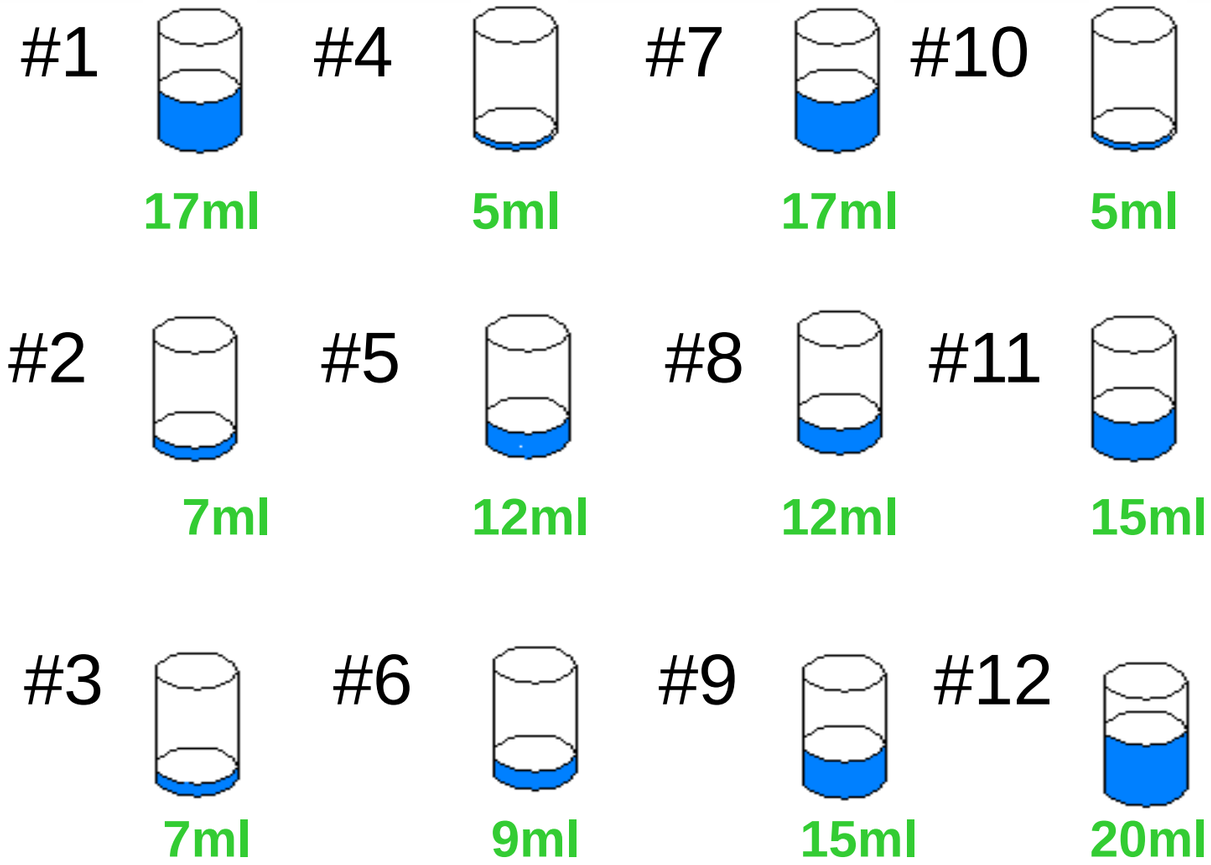


12 “Catchments”


#1
17ml
#4
5ml
#7
17ml
#10
5ml
#2
7ml
#5
12ml
#8
12ml
#11
15ml
#3
7ml
#6
9ml
#9
15ml
#12
20ml

Lower Quarter" DU

SORTED DATA	
Catchment #	Measured ml
4	5
10	5
2	7
3	7
6	9
5	12
8	12
9	15
11	15
1	17
7	17
12	20
	141
AVG =	11.8

Calculate "Lower Quarter" *DU*

1. Identify lowest 25% of catchments (in red)

2. Calculate average of lowest 25% (5+5+7)/3 = 5.7
= Lower Quarter Avg

3. Calculate "Lower Quarter" Distribution Uniformity

Lower Qtr Avg/Overall Avg
5.7 / 11.8 = 48.3% = DU_{LQ}

& Irrigation Sch

DU_{LQ} (Lower Quarter)

5.7 / 11.8 = 48.3%

SORTED DATA	
Catchment #	Measured ml
4	5
10	5
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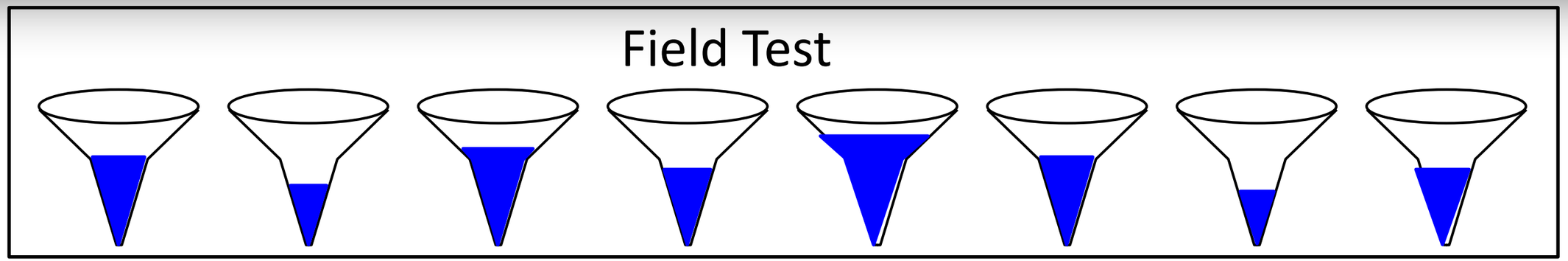
8	12
9	15
11	15
1	17
7	17
12	20
	141
AVG =	11.8

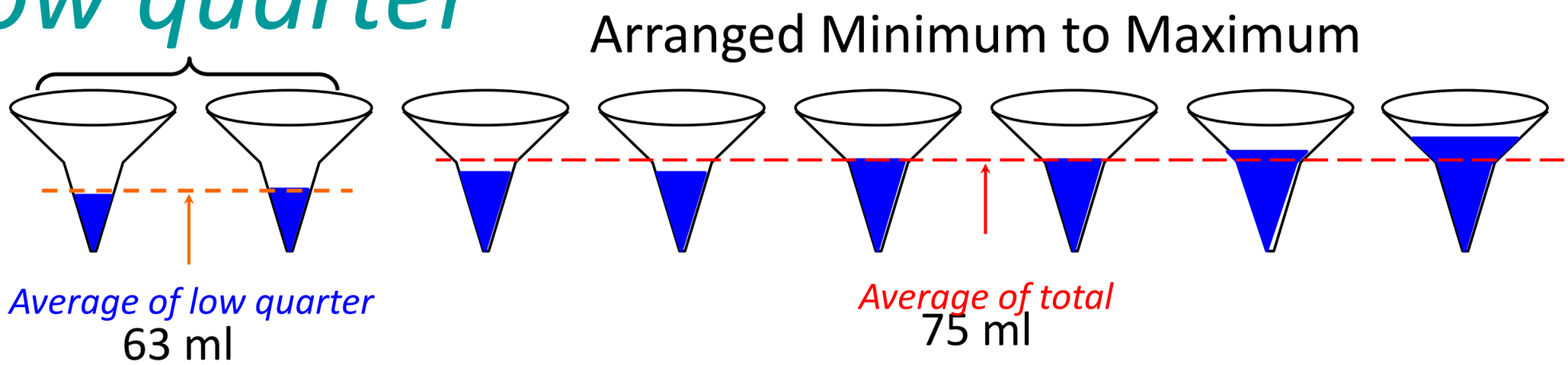
Conversion Table: DU_{LQ} to Scheduling Multiplier

DU_{LQ}	SM	DU_{LQ}	SM	DU_{LQ}	SM
1.00	1.00	0.78	1.15	0.56	1.36
0.98	1.01	0.76	1.17	0.54	1.38
0.96	1.02	0.74	1.18	0.52	1.40
0.94	1.04	0.72	1.20	0.50	1.43
0.92	1.05	0.70	1.22	0.48	1.45
0.90	1.06	0.68	1.24	0.46	1.48
0.88	1.08	0.66	1.26	0.44	1.51
0.86	1.09	0.64	1.28	0.42	1.53
0.84	1.11	0.62	1.30	0.40	1.56
0.82	1.12	0.60	1.32	Fix sprinkler zone 1st when DU_{LQ} < 0.40	
0.80	1.14	0.58	1.34		

Lower Quarter Distribution Uniformity



Low quarter



$$DU_{LQ} = \frac{63}{75} = .84$$

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Expected DU_{LQ}

Sprinkler Type	Achievable (DU_{LQ})	Target (DU_{LQ})	Historical (DU_{LQ})
Rotary Sprinklers	0.75 – 0.85	0.65 - 0.75	0.55 – 0.65
Spray Sprinklers	0.65 – 0.75	0.55 – 0.65	0.45 – 0.55

If lower than historical, consider system improvements

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Impact of Uniformity

Stared with:

DU is 100 and SC is 1.0

run time is 60 minutes Water applied is 1,559 gallons

DU is 0.67 and SC is 1.5

Run time is 90 minutes Water applied is 2,339 gallons

DU is 0.40 and SC is 2.5

Run time is 150 minutes Water applied is 3,898 gallons

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Precipitation Rate

The rate at which the sprinklers apply water

Measured in inches per hour (in./hr)

Varies from zone to zone and within a zone

Most systems' precipitation rates exceed the infiltration rate

There are two ways to calculate PR

- Gross or Theoretical Precipitation Rate
- Net Precipitation Rate

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Theoretical Precipitation Rate

Formula:

$$PR = \frac{96.3 \times Q}{A}$$

where:

PR = gross precipitation rate {in./hr}

Q = flow rate {gpm} Full Cir Noz

A = area {ft^2}

96.3 = Constant

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Where Does 96.3 Come From?

96.3 is the factor that converts GPM (gallons per minute) into "/HR (inches/hour)

- 0.623 gallons occupy the space made by a 1' x 1' x 1" shape.
- 7.48 gallons occupy the space made by a 1' x 1' x 1' shape (1 cubic foot).
- 748 gallons fit into 100 cubic feet.

$$60 \text{ min/hour} \times 12\text{"/foot} \times 100 \text{ ft}^3/748 \text{ g} = 96.3 \frac{\text{min in ft}^2}{\text{Hour gal}}$$

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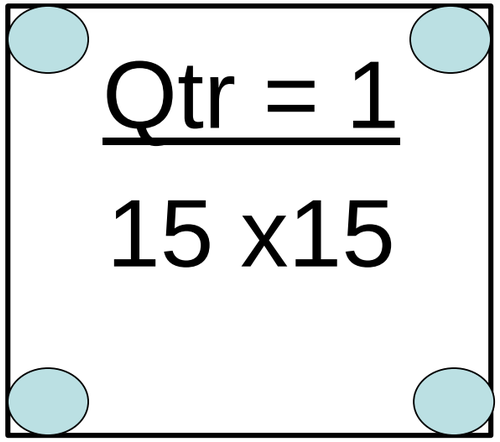
scheduling



Q = 3
40 x 40

$$\frac{96.3 \times Q}{\text{Area}}$$

$$\frac{96.3 \times 4}{15 \times 15} = 1.71''$$

$$\frac{96.3 \times 12}{40 \times 40} = .72''$$

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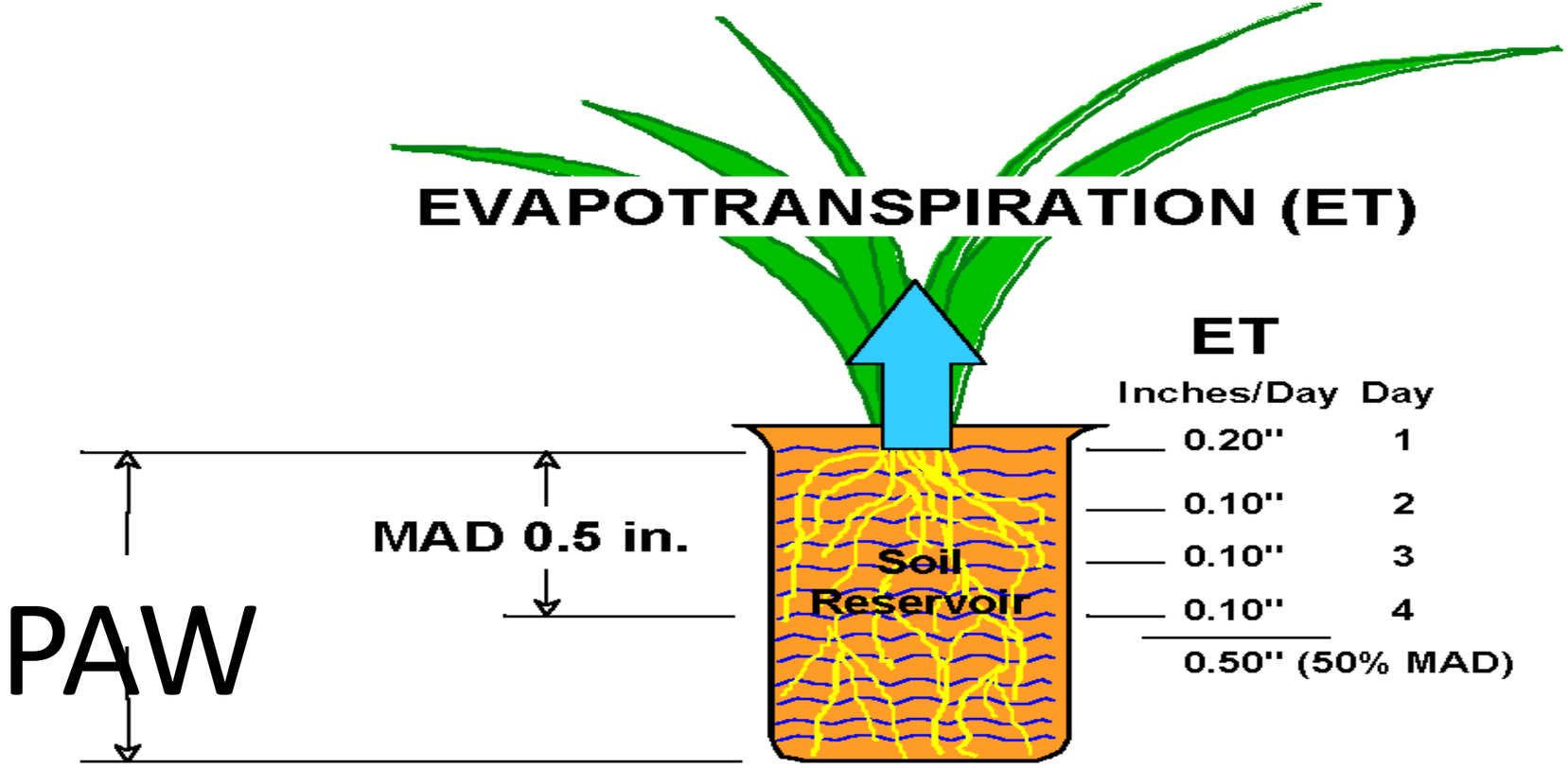
ET, PAW, and MAD



Therefore in 4 days, apply 0.50 inches of water

First need to begin with system capacity

Working Pressure

POC capacity

Velocity

Common Scenarios

Combining zones

PSI changes by changing heads

Converting heads

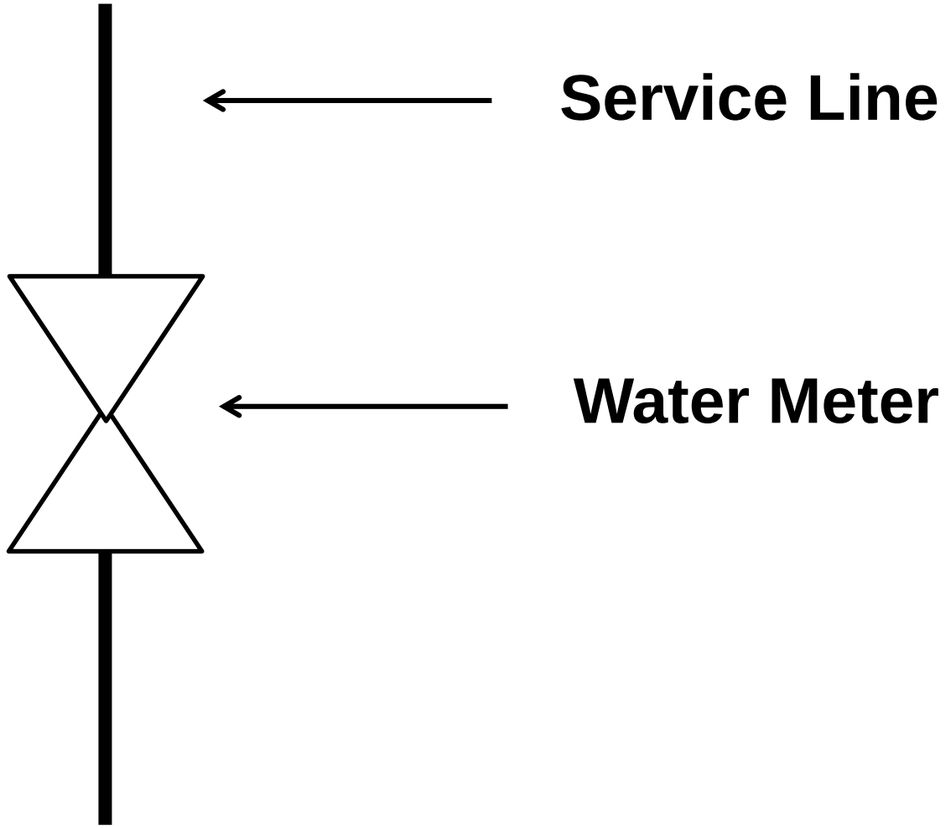
Adding heads

Determining Pressure & Flow

The “Rule of Three”

Using Water Meter, and Service Lines

Determining Pressure & Flow



Irrigation Association: Field Hydraulics

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The “Rule of Three”

Rule 1:
The maximum allowable loss through the meter should be less than ten percent (10%) of the inlet pressure at the meter. (80psi)

Pressure Loss–psi

FLOW GPM	NOMINAL SIZE			
	¾"	¾"	1"	1½"
1	0.2	0.1		
2	0.3	0.2		
3	0.4	0.3		
4	0.6	0.5	0.1	
5	0.9	0.6	0.2	
6	1.3	0.7	0.3	
7	1.8	0.8	0.4	
8	2.3	1.0	0.5	
9	3.0	1.3	0.6	
10	3.7	1.6	0.7	
11	4.4	1.9	0.8	
12	5.1	2.2	0.9	
13	6.1	2.6	1.0	
14	7.2	3.1	1.1	
15	8.3	3.6	1.2	
16	9.4	4.1	1.4	0.4
17	10.7	4.6	1.6	0.5
18	12.0	5.2	1.8	0.6
19	13.4	5.8	2.0	0.7
20	15.0	6.5	2.2	0.8
22		7.9	2.8	1.0
24		9.5	3.4	1.2
26		11.2	4.0	1.4
28		13.0	4.6	1.6
30		15.0	5.3	1.8
32			6.0	2.1

Irrigation Association: Field Hyc

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The “Rule of Three”

Rule 2:
The maximum flow (GPM) through the meter should be limited to 75% of the maximum safe flow through the meter

Pressure Loss–psi

FLOW GPM	NOMINAL SIZE			
	⅝"	¾"	1"	1⅛"
1	0.2	0.1		
2	0.3	0.2		
3	0.4	0.3		
4	0.6	0.5	0.1	
5	0.9	0.6	0.2	
6	1.3	0.7	0.3	
7	1.8	0.8	0.4	
8	2.3	1.0	0.5	
9	3.0	1.3	0.6	
10	3.7	1.6	0.7	
11	4.4	1.9	0.8	
12	5.1	2.2	0.9	
13	6.1	2.6	1.0	
14	7.2	3.1	1.1	
15	8.3	3.6	1.2	
16	9.4	4.1	1.4	0.4
17	10.7	4.6	1.6	0.5
18	12.0	5.2	1.8	0.6
19	13.4	5.8	2.0	0.7
20	15.0	6.5	2.2	0.8
22		7.9	2.8	1.0
24		9.5	3.4	1.2
26		11.2	4.0	1.4
28		13.0	4.6	1.6
30		15.0	5.3	1.8
32			6.0	2.1

Irrigation Association: Field

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The “Rule of Three”

Rule 3: The velocity of water flow (feet per second) through the service line supplying the meter should be approximately seven feet per second

TYPE ‘K’ COPPER TUBING

Size: ½″ thru 3″ Flow: 1 thru 600 GPM

ASTM B 88 C=140 PSI LOSS PER 100 FEET OF PIPE (PSI/100 FT)

size	½″		5/8″		¾″		1″		1¼″		1½″		2″		2½″	
Avg ID	0.527		0.652		0.745		0.995		1.245		1.481		1.959		2.435	
Pipe OD	0.625		0.750		0.875		1.125		1.375		1.625		2.125		2.625	
Avg Wall	0.049		0.049		0.065		0.065		0.065		0.072		0.083		0.095	
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	Velocity FPS	PSI Loss	Velocity FPS	PSI Loss
1	1.47	1.09	0.96	0.39	0.74	0.20	0.41	0.05	0.26	0.02						
2	2.94	3.94	1.92	1.40	1.47	0.73	0.82	0.18	0.53	0.06						
3	4.41	8.35	2.88	2.97	2.21	1.55	1.24	0.38	0.79	0.13						
4	5.88	14.23	3.84	5.05	2.94	2.64	1.65	0.65	1.05	0.22						
5	7.35	21.51	4.80	7.64	3.68	3.99	2.06	0.98	1.32	0.33						
6	8.81	30.15	5.76	10.70	4.41	5.59	2.47	1.37	1.58	0.46	1.12	0.20				
7	10.28	40.12	6.72	14.24	5.15	7.44	2.88	1.82	1.84	0.61	1.30	0.26				
8	11.75	51.37	7.68	18.24	5.88	9.53	3.30	2.33	2.11	0.78	1.49	0.34				
9	13.22	63.90	8.64	22.68	6.62	11.85	3.71	2.90	2.37	0.97	1.67	0.42				
10	14.69	77.66	9.60	27.57	7.35	14.41	4.12	3.52	2.63	1.18	1.86	0.51				
12			11.52	38.64	8.82	20.20	4.95	4.94	3.16	1.66	2.23	0.71	1.28	0.18		
14			13.44	51.41	10.29	26.87	5.77	6.57	3.69	2.21	2.60	0.95	1.49	0.24		
16			15.36	65.83	11.76	34.41	6.59	8.42	4.21	2.83	2.98	1.22	1.70	0.31		
18			17.28	81.88	13.23	42.80	7.42	10.47	4.74	3.52	3.35	1.51	1.91	0.39		
20					14.70	52.02	8.24	12.72	5.26	4.28	3.72	1.84	2.13	0.47		

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The Rule of “3” - Determining Flow Size of Zones

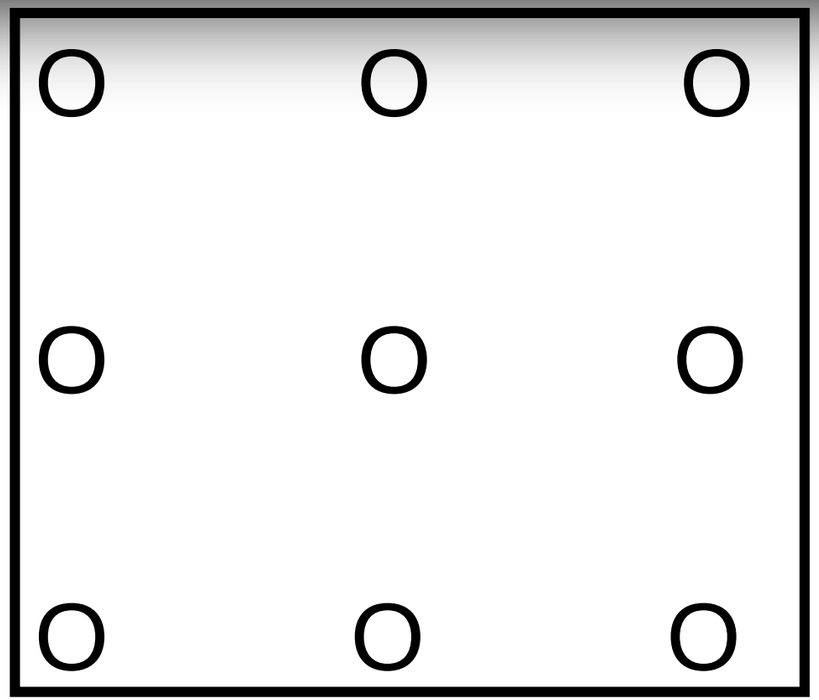
Make sure the gpm of the zone meets the worst case of the following three conditions

1. Friction loss through the meter does not exceed 10% of the static pressure at the site
2. Do not exceed 75% of the meter capacity
3. 7 - 9 feet per second velocity in service line

Practice

Rules of three:

1) 14gpm
2) 15gpm
3) 18gpm



4-Q 1.23= 5
4-H 2.14= 8.5
1-F 4.58
Total flow 18gpm

All 15' sprays at 50psi

Controller showed a 15min runtime.

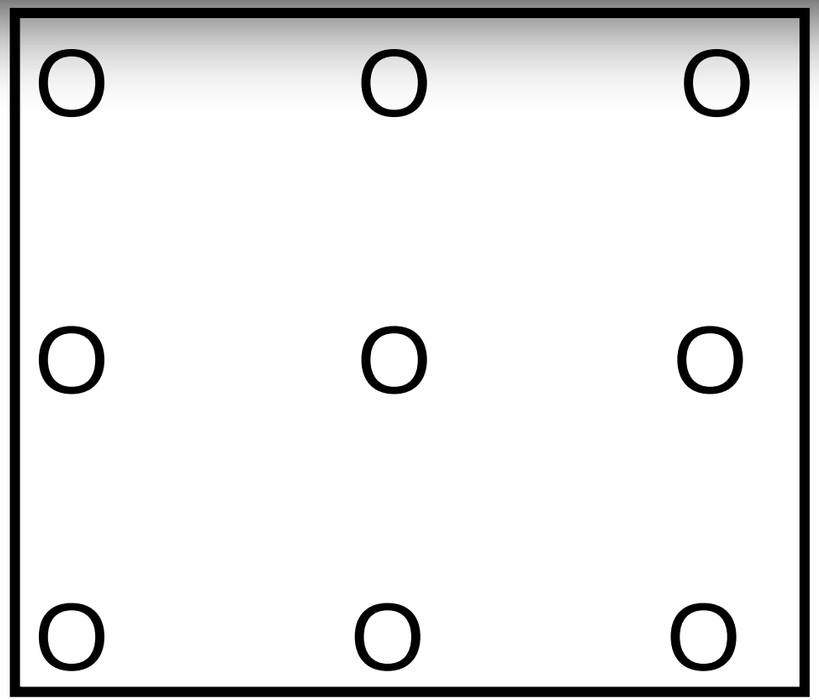
15' Series with 27° Trajectory

Nozzle	Pressure psi	Radius ft.	GPM	Precip. mm	Precip. mm
IPN-15F	20	13	2.85	1.63	1.89
	30	15	3.60	1.55	1.79
	40	16	4.20	1.59	1.84
	50	16	4.58	1.73	2.00
IPN-15TQ	20	13	2.10	1.61	1.85
	30	15	2.60	1.49	1.72
	40	16	3.00	1.61	1.86
	50	16	3.40	1.72	1.98
IPN-15TT	20	14	1.78	1.38	1.59
	30	15	2.20	1.42	1.64
	40	16	2.66	1.51	1.74
	50	16	2.84	1.61	1.86
IPN-15H	20	13	1.37	1.55	1.79
	30	15	1.65	1.44	1.66
	40	16	2.02	1.53	1.77
	50	16	2.14	1.62	1.87
IPN-15T	20	14	0.95	1.52	1.75
	30	15	1.10	1.42	1.64
	40	16	1.30	1.57	1.82
	50	16	1.45	1.75	2.03
IPN-15Q	20	14	0.68	1.34	1.55
	30	15	0.85	1.46	1.69
	40	16	1.04	1.57	1.82
	50	16	1.23	1.86	2.15

Practice

Rules of three:

1) 14gpm
2) 15gpm
3) 18gpm



4-Q 0.85= 3.4
4-H 1.65= 6.6
1-F 3.60
Total flow 13.6gpm

All 15' sprays at 50psi

Controller showed a 15min runtime.

Now try 30 psi

15' Series with 27° Trajectory

Nozzle	Pressure psi	Radius ft.	GPM	Precip. ■ in/h	Precip. ▲ in/h
IPN-15F	20	13	2.85	1.63	1.89
	30	15	3.60	1.55	1.79
	40	16	4.20	1.59	1.84
	50	16	4.58	1.73	2.00
IPN-15TQ	20	13	2.10	1.61	1.85
	30	15	2.60	1.49	1.72
	40	16	3.00	1.61	1.86
	50	16	3.40	1.72	1.98
IPN-15TT	20	14	1.78	1.38	1.59
	30	15	2.20	1.42	1.64
	40	16	2.66	1.51	1.74
	50	16	2.84	1.61	1.86
IPN-15H	20	13	1.37	1.55	1.79
	30	15	1.65	1.44	1.66
	40	16	2.02	1.53	1.77
	50	16	2.14	1.62	1.87
IPN-15T	20	14	0.95	1.52	1.75
	30	15	1.10	1.42	1.64
	40	16	1.30	1.57	1.82
	50	16	1.45	1.75	2.03
IPN-15Q	20	14	0.68	1.34	1.55
	30	15	0.85	1.46	1.69
	40	16	1.04	1.57	1.82
	50	16	1.23	1.86	2.15

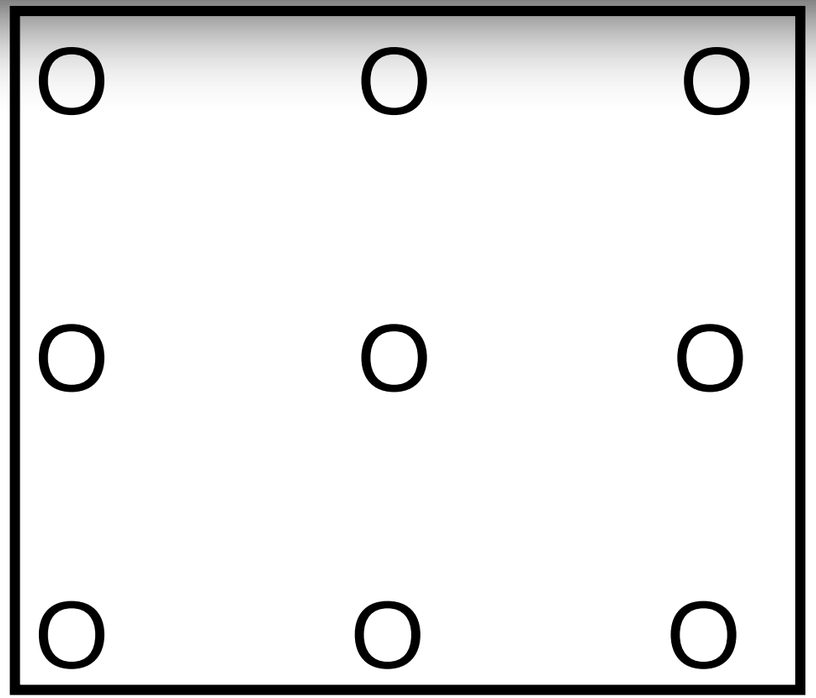
Practice

Rules of three:

1) 14gpm

2) 15gpm

3) 18gpm



All 15’ sprays at 50psi

Controller showed a 15min runtime.

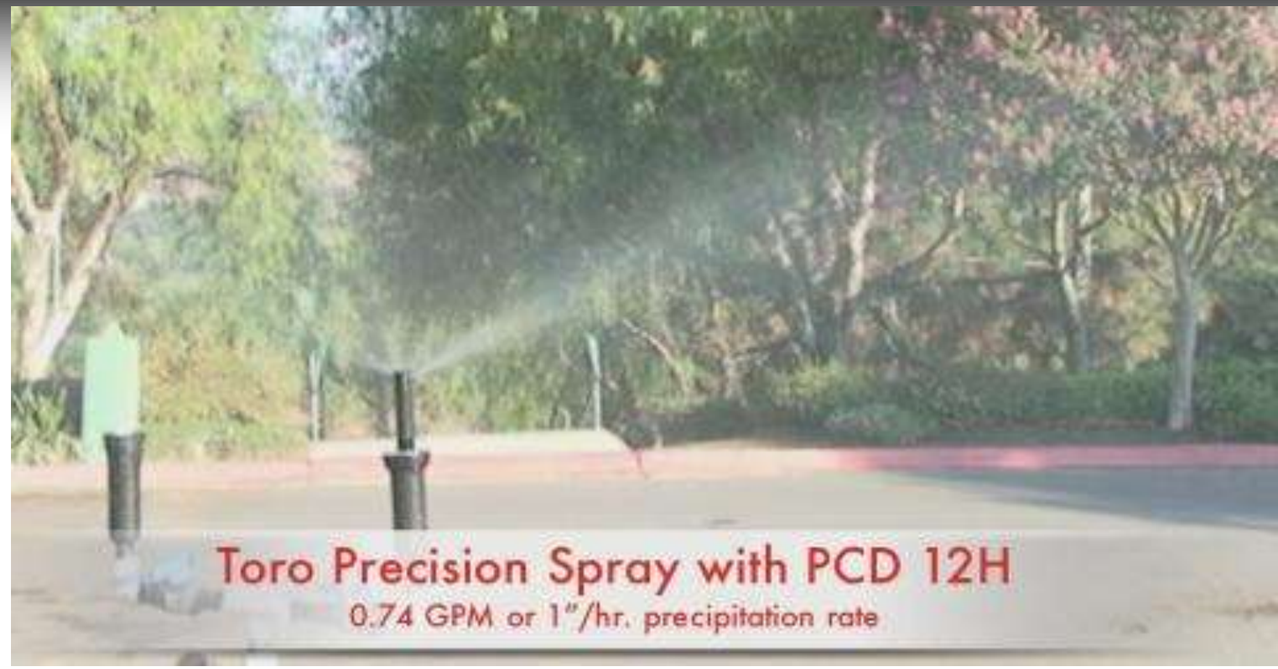
New flow 9.27gpm

Arc	PSI	GPM	Radius	Precip.Rate ⊠ (in./hr.)
15Q	40	0.53	14.2	1.0
	50	0.58	15.0	1.0
	60	0.58	15.0	1.0
	70	0.58	15.0	1.0
15T	40	0.72	14.3	1.0
	50	0.77	15.0	1.0
	60	0.77	15.0	1.0
	70	0.77	15.0	1.0
15H	40	1.10	14.5	1.0
	50	1.16	15.0	1.0
	60	1.16	15.0	1.0
	70	1.16	15.0	1.0
15TT	40	1.45	14.5	1.0
	50	1.54	15.0	1.0
	60	1.54	15.0	1.0
	70	1.54	15.0	1.0
15TQ	40	1.72	14.5	1.0
	50	1.78	15.0	1.0
	60	1.78	15.0	1.0
	70	1.78	15.0	1.0
15F	40	2.20	14.5	1.0
	50	2.31	15.0	1.0
	60	2.31	15.0	1.0
	70	2.31	15.0	1.0

Courtesy of Toro Irrigation

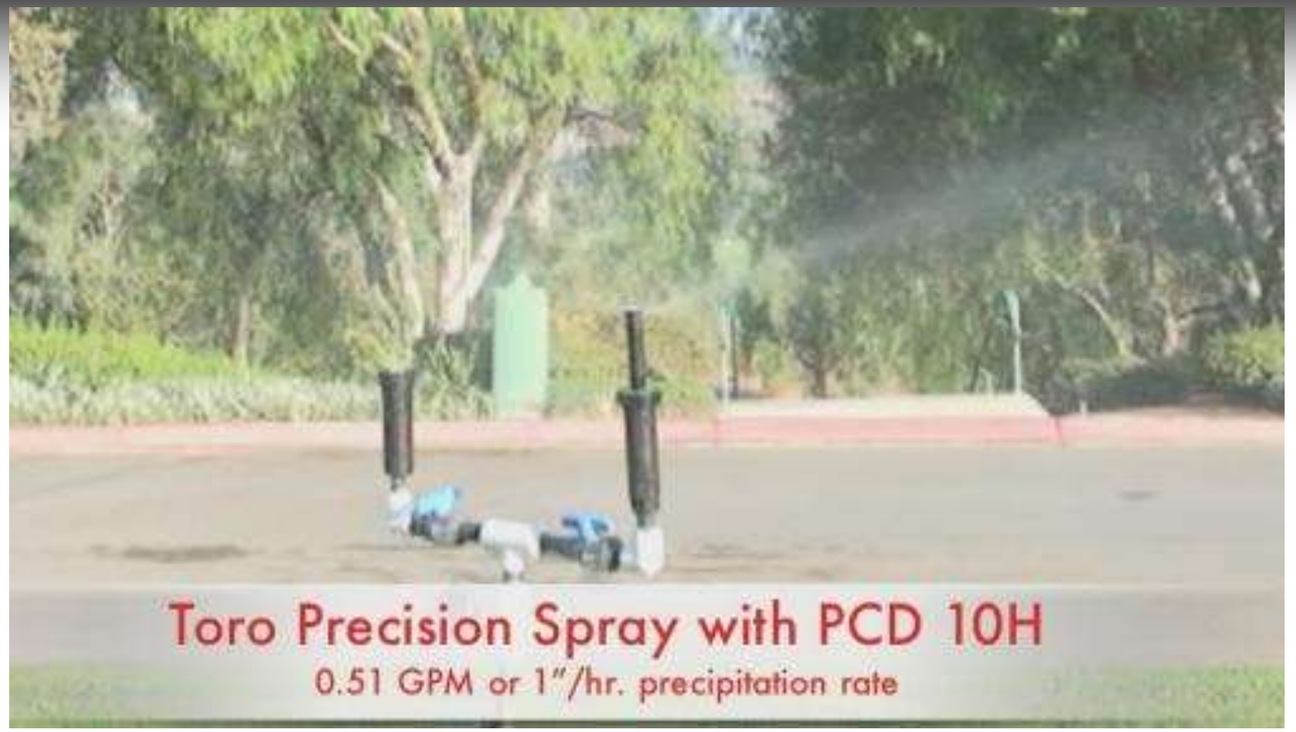
51% Lower Precipitation Rate = Reduced Water Waste!

15H Performance at 50 PSI



57% Lower Precipitation Rate = Reduced Water Waste!

12H Performance at 50 PSI

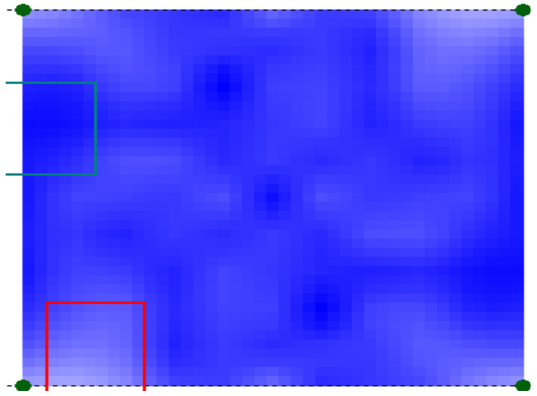


51% Lower Precipitation Rate = Reduced Water Waste!

10H Performance at 50 PSI

AB1881 Design Requirement

Head to head coverage is recommended. However, sprinkler spacing shall be set and designed to achieve the highest possible distribution uniformity using the manufacturer's specifications & recommendations.



Sprinkler Name	TORO PRECISION SPRAY	**Base Pressure (PSI)**	30.0
Sprinkler Model	O-T	**Riser Height (IN)**	4.0
Nozzle Size	10H #1	**Set Screw Setting**	
Flow Rate (GPM)	0.60	**Degree of Arc**	180
Date/Time of Test	07/10/09	**Mins./Revolution**	0.00
Testing Facility	C. I. T.	**Record Number**	
Comment	Sprinkler provided by: TORO		
Catchment Spacing	0.5'		

Distr. Uniformity	81%	**Min (In/Hr)**	0.426			**Spacing**
CU (Christiansen)	90%	**Mean(In/Hr)**	0.888	N/A	**(Theor.)**	Rectangular
Sched Coeff (5%)	1.4	**Max (In/Hr)**	1.157			10.0' x 10.0'

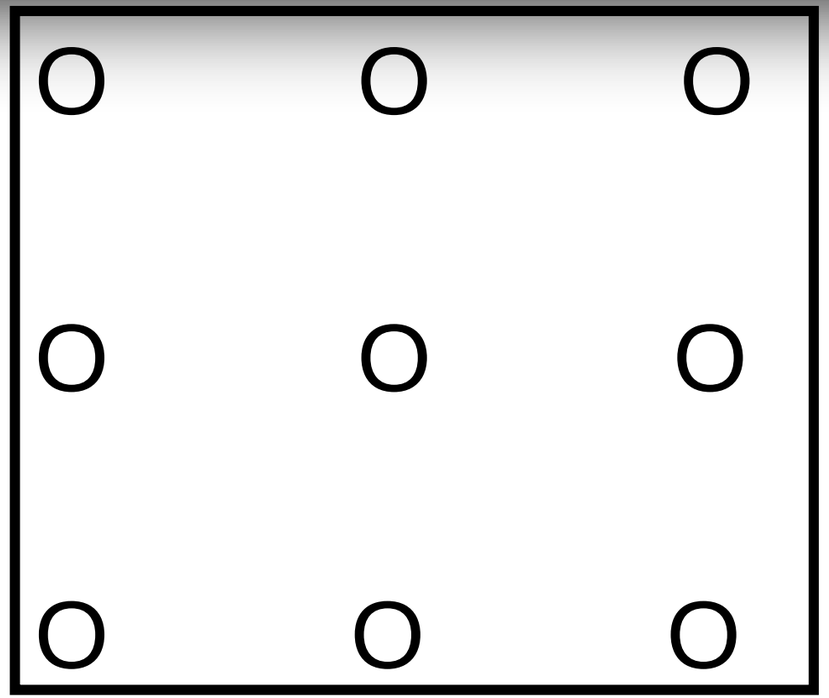
Practice

Rules of three:

1) 14gpm

2) 15gpm

3) 18gpm



All 15’ sprays at 50psi

Controller showed a 15min runtime.

15 Series HE-VAN

25° Trajectory

Nozzle	Pressure psi	Radius ft.	Flow gpm	Precip In/h
360° Arc	15	11	2.62	2.08
	20	12	3.02	2.02
	25	14	3.38	1.66
	30	15	3.70	1.58
270° Arc	15	11	1.96	2.08
	20	12	2.27	2.02
	25	14	2.53	1.66
	30	15	2.78	1.58
180° Arc	15	11	1.31	2.08
	20	12	1.51	2.02
	25	14	1.69	1.66
	30	15	1.85	1.58
90° Arc	15	11	0.65	2.08
	20	12	0.76	2.02
	25	14	0.84	1.66
	30	15	0.93	1.58

Courtesy of Rainbird Irrigation

New flow 14.83gpm measured at 30psi (x1.27) or 18.83

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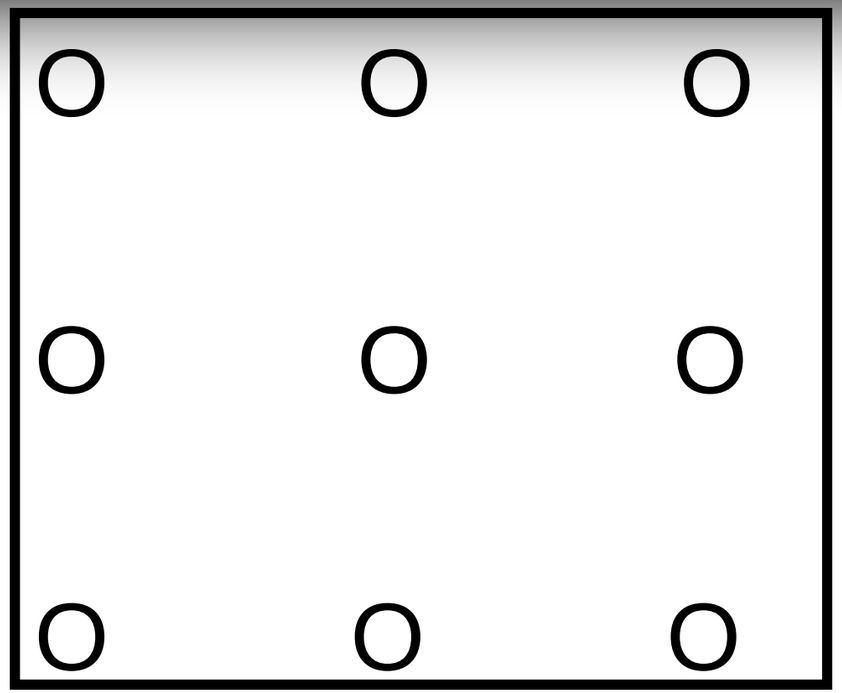
Practice

Rules of three:

1) 14gpm

2) 15gpm

3) 18gpm



All 15’ sprays at 50psi

Controller showed a 15min runtime.

90°	20	0.43	16.0	0.65
	30	0.49	17.5	0.62
	40	0.62	20.5	0.57
	50	0.75	22.5	0.57
	60	0.82	23.5	0.57
	75	0.92	25.0	0.57
180°	20	0.83	15.0	0.71
	30	0.94	17.0	0.63
	40	1.22	20.5	0.56
	50	1.46	22.5	0.56
	60	1.61	24.0	0.54
	75	1.81	26.0	0.52
360°	20	1.81	15.0	0.77
	30	2.00	17.2	0.65
	40	2.56	20.9	0.56
	50	3.09	22.9	0.57
	60	3.34	23.8	0.57
	75	3.68	25.6	0.54

Courtesy of Toro Irrigation

New flow 11.93gpm

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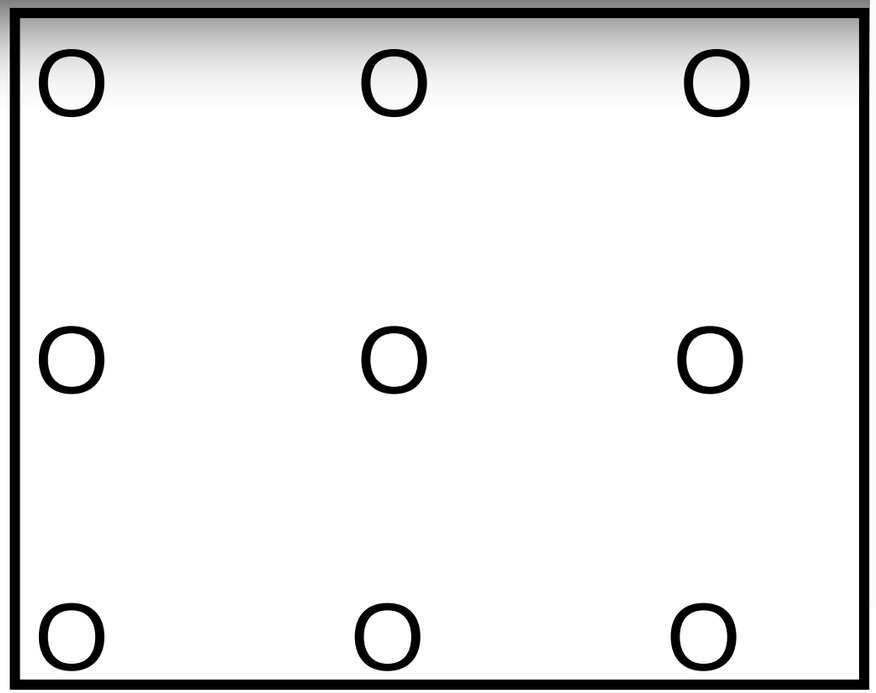
Practice

Rules of three:

1) 14gpm

2) 15gpm

3) 18gpm



All 15’ sprays at 50psi

Controller showed a 15min runtime.

New flow 3.32gpm

Arc	Pressure			Radius	Flow		Precip in/hr	
	PSI			ft	GPM	GPH	■	▲
90°	25			...	...	...	...	...
	30			12	0.16	9.6	0.43	0.50
	35			13	0.18	10.8	0.40	0.46
	40			14	0.19	11.4	0.39	0.45
	45			14	0.20	12.0	0.39	0.45
	50			14	0.21	12.6	0.38	0.43
	55			15	0.22	13.2	0.37	0.43
180°	25			...	...	...	...	...
	30			12	0.32	19.2	0.43	0.50
	35			13	0.35	21.0	0.40	0.46
	40			14	0.43	25.8	0.39	0.45
	45			14	0.40	24.0	0.39	0.45
	50			14	0.41	24.6	0.38	0.43
360°	25			...	...	...	...	...
	30			12	0.65	39.0	0.43	0.50
	35			13	0.71	42.6	0.40	0.47
	40			14	0.75	45.0	0.39	0.46
	45			14	0.80	48.0	0.39	0.45
	50			14	0.84	50.4	0.38	0.44
	55			15	0.87	52.2	0.37	0.43

Courtesy of Hunter Industries

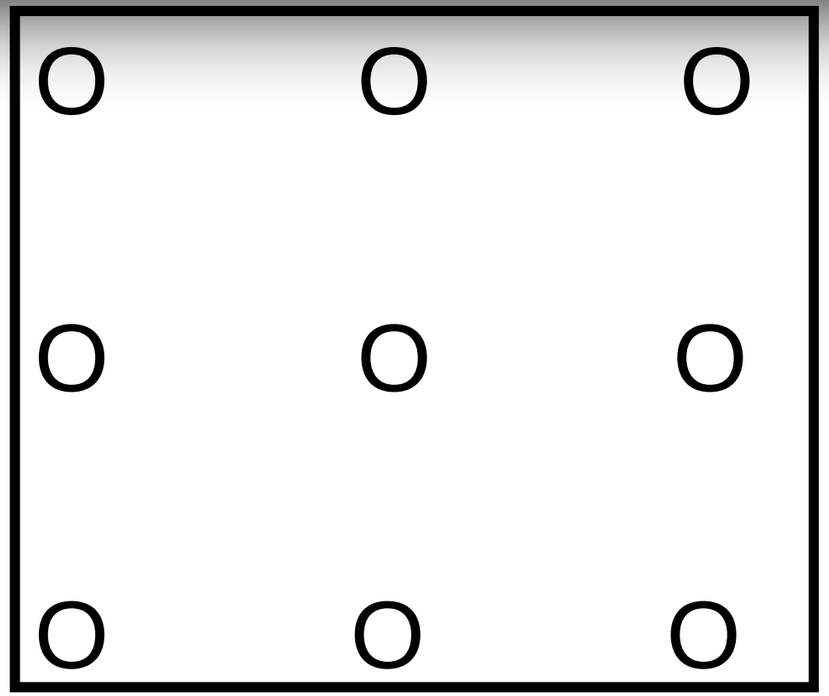
Practice

Rules of three:

1) 14gpm

2) 15gpm

3) 18gpm



All 15’ sprays at 50psi Controller showed a 15min runtime.

New flow 8.27gpm

R13-18 Series (Black)

Arc	Pressure psi	Radius* ft.	Flow gpm	■ Precip In/h	▲ Precip In/h
R13-18F	20	13	1.31	0.75	0.86
	25	14	1.46	0.67	0.77
	30	16	1.60	0.61	0.70
	35	16	1.73	0.61	0.70
	40	17	1.85	0.61	0.70
	45	18	1.96	0.61	0.70
	50	18	2.07	0.61	0.70
	55	18	2.17	0.61	0.70
R13-18H	20	13	0.65	0.75	0.86
	25	14	0.73	0.67	0.77
	30	16	0.80	0.61	0.70
	35	16	0.86	0.61	0.70
	40	17	0.92	0.61	0.70
	45	18	0.98	0.61	0.70
	50	18	1.03	0.61	0.70
	55	18	1.08	0.61	0.70
R13-18T	20	13	0.44	0.75	0.86
	25	14	0.49	0.67	0.77
	30	16	0.53	0.61	0.70
	35	16	0.58	0.61	0.70
	40	17	0.62	0.61	0.70
	45	18	0.65	0.61	0.70
	50	18	0.69	0.61	0.70
	55	18	0.72	0.61	0.70
R13-18Q	20	13	0.33	0.75	0.86
	25	14	0.37	0.67	0.77
	30	16	0.40	0.61	0.70
	35	16	0.43	0.61	0.70
	40	17	0.46	0.61	0.70
	45	18	0.49	0.61	0.70
	50	18	0.52	0.61	0.70
	55	18	0.54	0.61	0.70

Courtesy of Rainbird Irrigation

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Application Efficiency

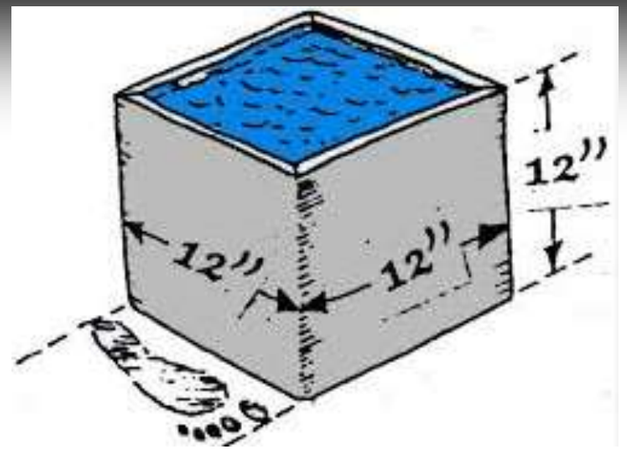
The ratio of total water applied to the total water infiltrated and stored in the soil

Often mistakenly used interchangeably with uniformity

Efficiency is affected by

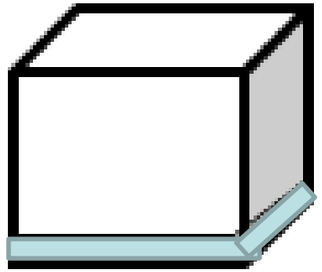
- Uniformity
- Scheduling
- Maintenance

Facts About Water



1 Cubic Foot of Water

- 7.48 Gallons



1 Sq Ft filled 1" high with water

- Equivalent to 0.623 gallons

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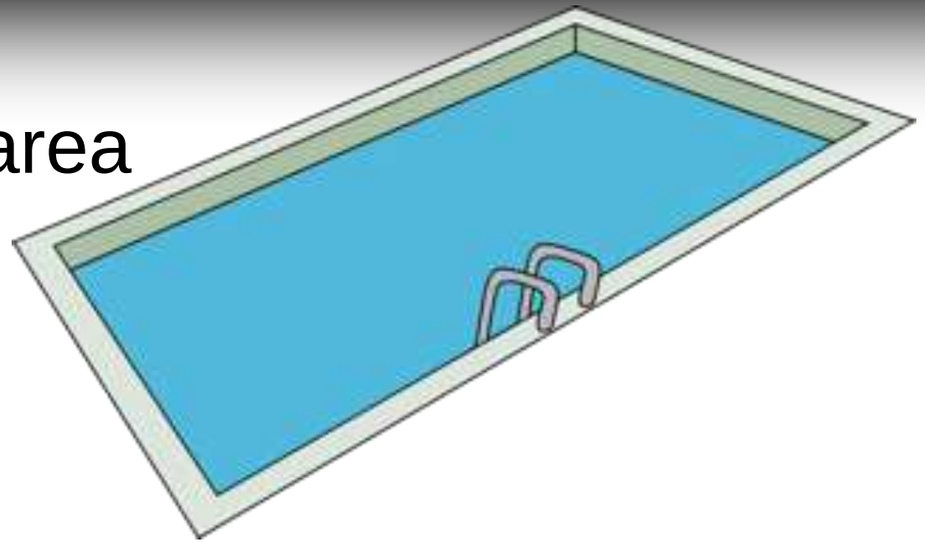
Pool Evaporation - 100% ET

Pool evaporation: 1000 sq ft surface area



Water Use Equation:

ET (inches/yr) **x** 0.623 **x** sq. ft

Gallons lost in 1 year from pool through evaporation

55 in x .623 gal/in-ft^2 x 547 ft^2 = 18,743g = 25 units x $10 = $250/year or $20.83/month

16 feet 4 inches by 33 feet 6 inches: typical pool size in study area

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“Plant Factors”

- The Reference Crop or Plant has a Value of 1.0
- How do other “Plants” compare to the reference crop?
    - Cool Season Turf = .8
    - Warm Season Turf = .6
    - Ground Cover = .6
    - Shrubs (w/o GC) = .5
    - Drought Tolerant & Natives = .3

Turf Water Use vs. Pool Evaporation

Use the same 1000 square foot area as the pool, but adjust equation for turfgrass.

This requires adding two decimal numbers to the equation. A “PF” Plant Factor in the numerator & an “IE” Irrigation Efficiency number in the denominator as follows.

Annual Turf Water Use *(in gallons)* Equation:

[ET (inches/yr) x (PF) X 0.623 x sq. ft] / IE

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ET – Plant – Soil Relationships

WEATHER – ET (*Evaporation + Plant Transpiration*)

Tempº | **Solar Radiation** | **Humidity** | **Wind**

PLANT **(Water User)**

- Plant Type – Plant Factor
- Planting Density
- Microclimate

(Water Delivery) **SPRINKLER SYSTEM**

- Application Rate (“/hr)
- Uniformity (How Even)
- Scheduling Multiplier (IA)

SOIL ***(Water Reservoir)***

- Clay/Silt/Sand Combination
- Intake Rate (inches/hour)
- Plant Available Water
- Management Allowed Depletion

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Weather, ET & The Irrigation Schedule

WEATHER = ET (inches)

↓ Temp° ↓ Solar Radiation ↓ Humidity ↓ Wind ↓

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TTL
2.1	2.7	3.7	4.7	5.1	6.0	7.1	6.7	5.6	4.2	2.6	2.0	52.5

Historical Monthly ET For Pasadena, CA

29.6%	38.0%	52.1%	66.2%	71.8%	84.5%	100%	94.4%	78.9%	59.2%	36.6%	28.2%

Monthly Water Budget %

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Application Efficiency Equation

$$\frac{\text{SQ' x PWR(ET) x .623 (conversion from " to gal.)}}{\text{Amount actually used}} = \%$$

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Application Efficiency Equation

$$E_a = \frac{\text{Irrigation water beneficially used}}{\text{Irrigation water applied}} x100$$

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Plant Material & Irrigation Technologies Drive Annual Water Use

Turf Water Use Equation *(gallons per year)*

[ET (inches/yr) x (PF) X 0.623 x sq. ft] / IE

Keys to lower water use

- Selecting turf grasses with PFs at or below 0.6
- Making sure irrigation system is efficient and scheduling correct
- Dedicating more of landscape to drought tolerant plant material
  - Permits use of lower PF

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Water budget

- Determine proper water requirement needed
- Compare to what was applied
- Difference is the justification

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Interdependent Elements

"Water use efficiency is obtained by appropriate design and installation, but landscape water management and appropriate horticultural practices are what produce and ensure desired results."

2014 IA BMPs

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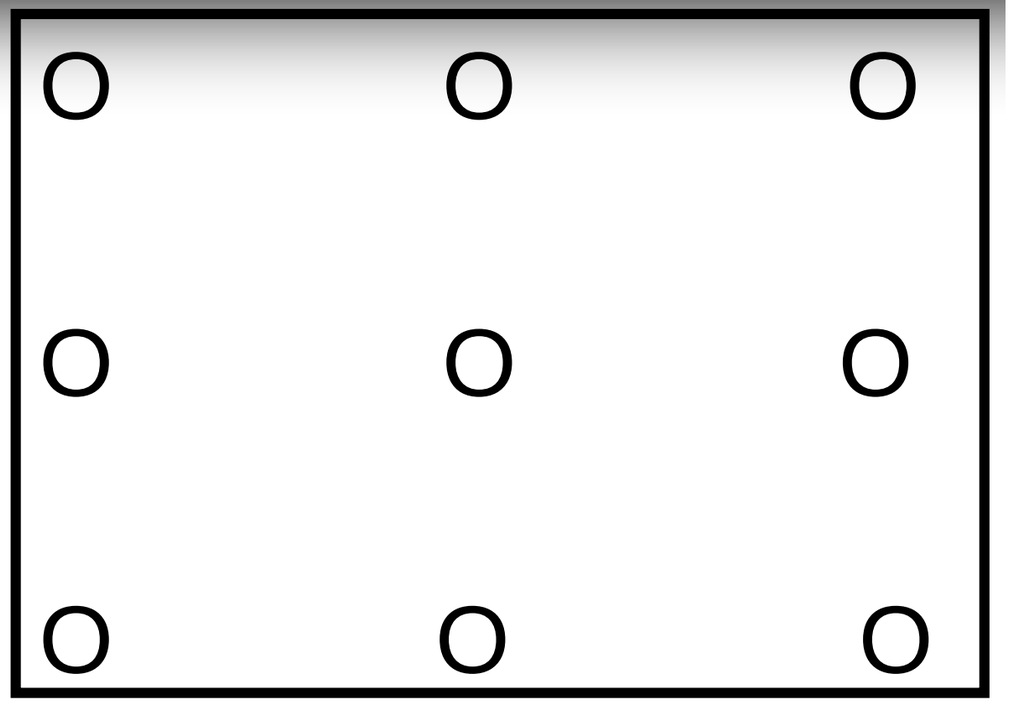
Practice



All 15’ sprays at 50psi

Controller showed a 15min runtime.

Remember 18.02

15' Series with 27° Trajectory

Nozzle	Pressure psi	Radius ft.	GPM	Precip. mm/h	Precip. inch
IPN-15F	20	13	2.85	1.63	1.89
	30	15	3.60	1.55	1.79
	40	16	4.20	1.59	1.84
	50	16	4.58	1.73	2.00
IPN-15TQ	20	13	2.10	1.61	1.85
	30	15	2.60	1.49	1.72
	40	16	3.00	1.61	1.86
	50	16	3.40	1.72	1.98
IPN-15TT	20	14	1.78	1.38	1.59
	30	15	2.20	1.42	1.64
	40	16	2.66	1.51	1.74
	50	16	2.84	1.61	1.86
IPN-15H	20	13	1.37	1.55	1.79
	30	15	1.65	1.44	1.66
	40	16	2.02	1.53	1.77
	50	16	2.14	1.62	1.87
IPN-15T	20	14	0.95	1.52	1.75
	30	15	1.10	1.42	1.64
	40	16	1.30	1.57	1.82
	50	16	1.45	1.75	2.03
IPN-15Q	20	14	0.68	1.34	1.55
	30	15	0.85	1.46	1.69
	40	16	1.04	1.57	1.82
	50	16	1.23	1.86	2.15

Compare Run Times

Old flow x run time

Compare new flow x run time

4 x 1.23 = 4.92	4 x .85 = 3.4
4 x 2.14 = 8.56	4 x 1.65 = 6.6
1 x 4.58 = 4.58	1 x 3.6 = 3.6
18.02 per application	13.6 per application

18.02 – 13.6 = 4.42gpm savings per application per zone

Must also consider over spray

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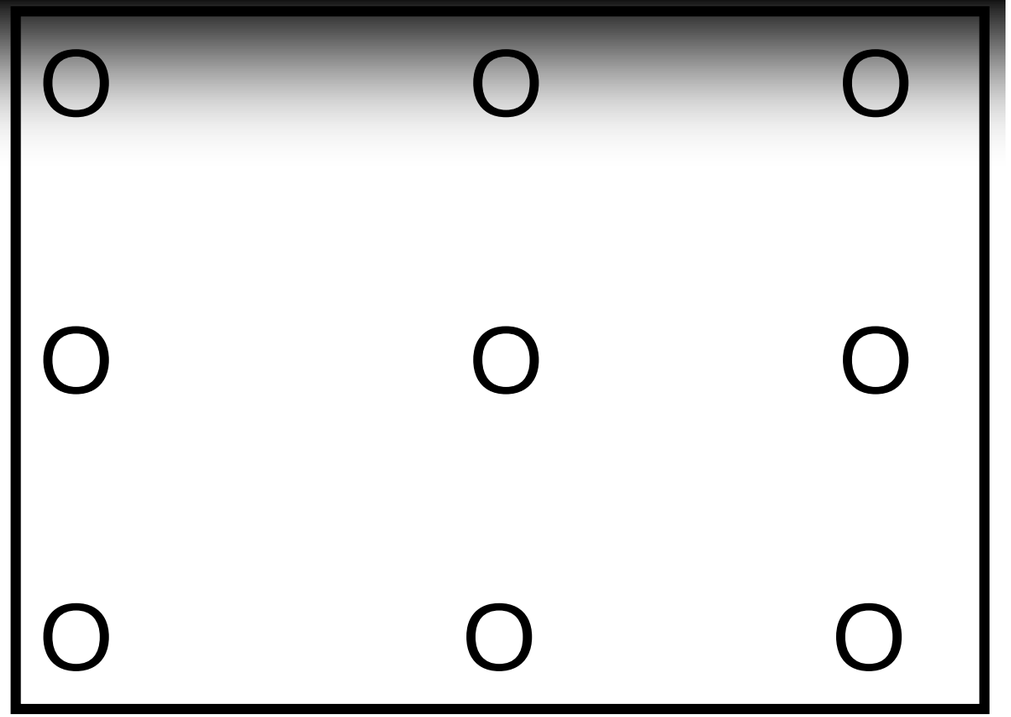
Practice



All 15’ sprays at 50psi

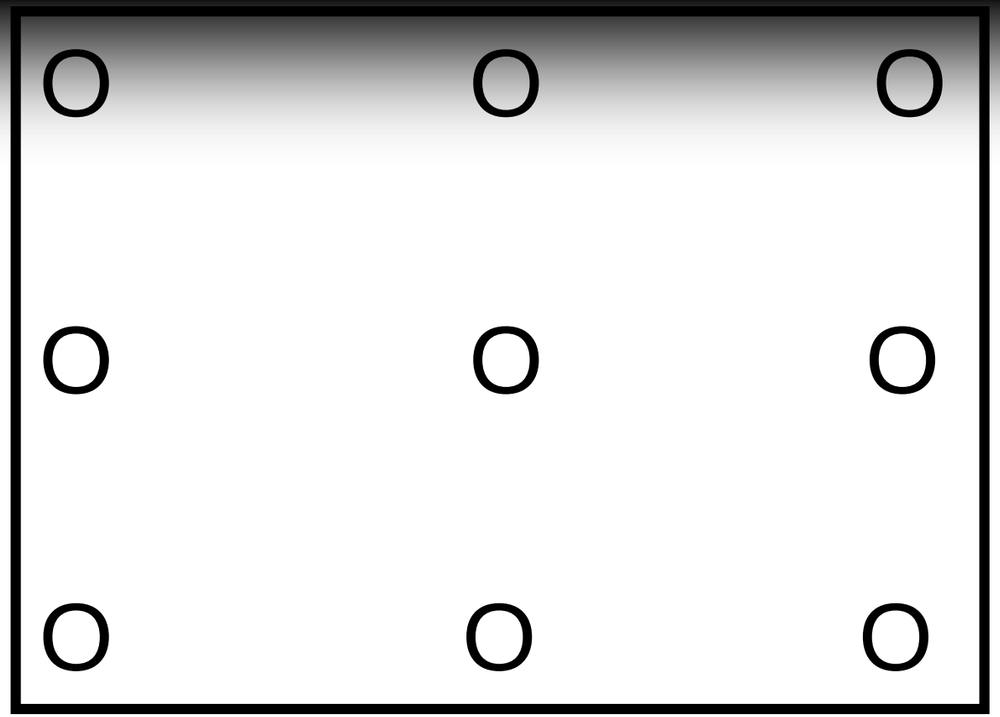
Controller showed a 15min runtime.

Remember 18.02gpm

15' Series with 27° Trajectory

Nozzle	Pressure psi	Radius ft.	GPM	Precip. mm/h	Precip. inch/h
IPN-15F	20	13	2.85	1.63	1.89
	30	15	3.60	1.55	1.79
	40	16	4.20	1.59	1.84
	50	16	4.58	1.73	2.00
IPN-15TQ	20	13	2.10	1.61	1.85
	30	15	2.60	1.49	1.72
	40	16	3.00	1.61	1.86
	50	16	3.40	1.72	1.98
IPN-15TT	20	14	1.78	1.38	1.59
	30	15	2.20	1.42	1.64
	40	16	2.66	1.51	1.74
	50	16	2.84	1.61	1.86
IPN-15H	20	13	1.37	1.55	1.79
	30	15	1.65	1.44	1.66
	40	16	2.02	1.53	1.77
	50	16	2.14	1.62	1.87
IPN-15T	20	14	0.95	1.52	1.75
	30	15	1.10	1.42	1.64
	40	16	1.30	1.57	1.82
	50	16	1.45	1.75	2.03
IPN-15Q	20	14	0.68	1.34	1.55
	30	15	0.85	1.46	1.69
	40	16	1.04	1.57	1.82
	50	16	1.23	1.86	2.15

Practice



All 15’ sprays at 50psi

Controller showed a 15min runtime.

New flow 9.27gpm

Arc	PSI	GPM	Radius	Precip.Rate ⊠ (in./hr.)
15Q	40	0.53	14.2	1.0
	50	0.58	15.0	1.0
	60	0.58	15.0	1.0
	70	0.58	15.0	1.0
15T	40	0.72	14.3	1.0
	50	0.77	15.0	1.0
	60	0.77	15.0	1.0
	70	0.77	15.0	1.0
15H	40	1.10	14.5	1.0
	50	1.16	15.0	1.0
	60	1.16	15.0	1.0
	70	1.16	15.0	1.0
15TT	40	1.45	14.5	1.0
	50	1.54	15.0	1.0
	60	1.54	15.0	1.0
	70	1.54	15.0	1.0
15TQ	40	1.72	14.5	1.0
	50	1.78	15.0	1.0
	60	1.78	15.0	1.0
	70	1.78	15.0	1.0
15F	40	2.20	14.5	1.0
	50	2.31	15.0	1.0
	60	2.31	15.0	1.0
	70	2.31	15.0	1.0

Courtesy of Toro Irrigation

Calculate Flow

Old flow x run time

Compare new flow x run time

18.01gpm x 15min = 270.15gpa

270.15 x 5days = 1,350.75 week x 4 = 5,403 month

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With Only PSI Reg.

Old flow x run time
Compare new flow x run time

13.6gpm x 15min = 204gpa

204 x 5days = 1,020 week x 4 = 4,080 month

5,403 – 4,080 = 1,323 savings per month per zone

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Specialty nozzle

Old flow x run time

Compare new flow x run time

9.27gpm x 15min = 139.05gpa

139.05 x 5days = 695.25 per week x 4 = 2,781 month

5,403 – 2,781 = 2,622 savings per month per zone

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Water costs

Single Family Monthly Water Volume Charges:

Volume	Inside City	Outside City
Year Round Rates		
First 10,000 gallons	$1.60	$2.24
Next 10,000 gallons	$2.08	$2.92
Next 40,000 gallons	$2.62	$3.67
Over 60,000 gallons	$3.27	$4.58

Remember to savings…

2,622 gpm per application per zone each month!!

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The Cost of Water

Old flow x run time
Compare new flow x run time

5,403 x 6 zones = 32,418

Chandler water rate is tier 2 is $2.08/1000 Gal

33 x 2.08= 68.64 cost per month for the 6 zones

Or **$823.68** per year just for the water

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Return on Investment

Old flow x run time

Compare new flow x run time

2,781 x 6 zones =16,686 or 17 units

Chandler water rate is 2.068unit

17 x 2.08 = 35.36 Cost per month per 6 zones

68.64 – 35.36 = 33.28 savings per month per 6 zones

For the year that is **$399.36** !!

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Return on Investment

Old flow x run time

Compare new flow x run time

We had 9 heads on the zone List price to up-grade the zone

9 heads 4” PR-COM $11.20 = $100.80

Nozzles List price $40.05

List price for 6 zones is $845.10

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Return on Investment

Water currently is $824 per year as is. With up-grade savings is $399 per year!!

List price for 6 zones is $845.10

Labor 2 guys 8 hours. If $50 per guy that $800

Product of 845.10 = 1,645 for the job.

Or a <u>4 year</u> return on the investment.

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Return on Investment

Old flow x run time

Compare new flow x run time

This is just the savings for nozzle and head change out

More savings will come from other product enhancements (stay tuned)

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Gpm and Run time

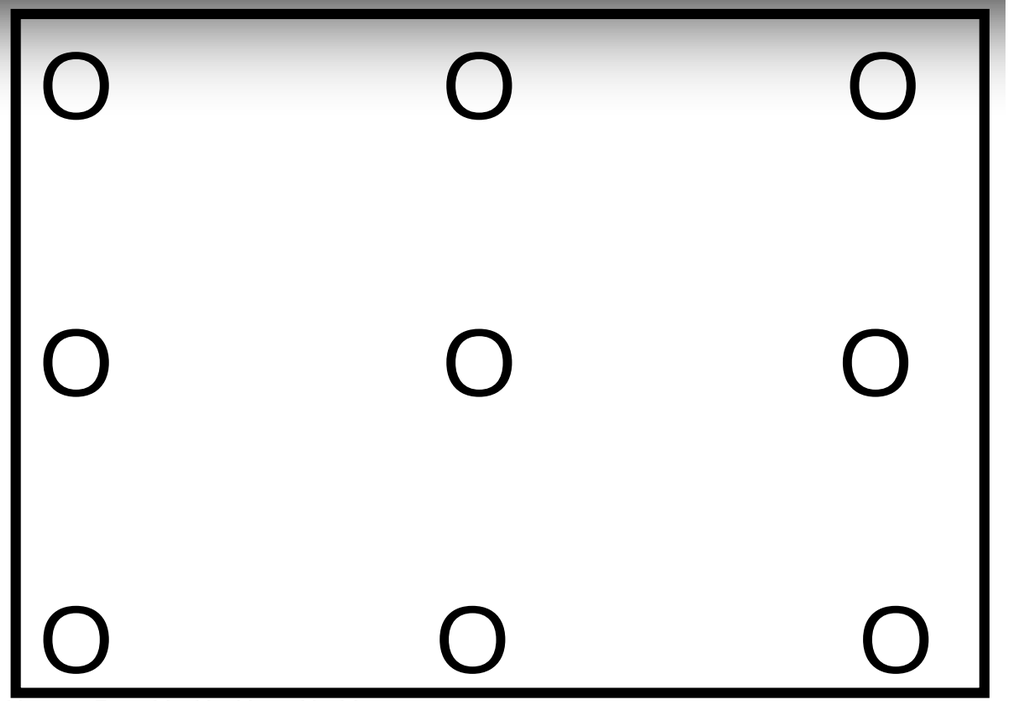
Precipitation Rate: $\frac{96.3 \times GPM\text{-}TZ}{SQ\ Ft.\ Zone}$

Run Time: $\frac{ET_L}{PR} \times 60$

Practice

Rules of three:

1) 14gpm
2) 15gpm
3) 18gpm



96.3X13.6=1,309.68

30X30 = 900 =1.45

.17

1.45 = .117X60 = 7min

Or 10 with SM

New Run time

1) PR

2) Run Time

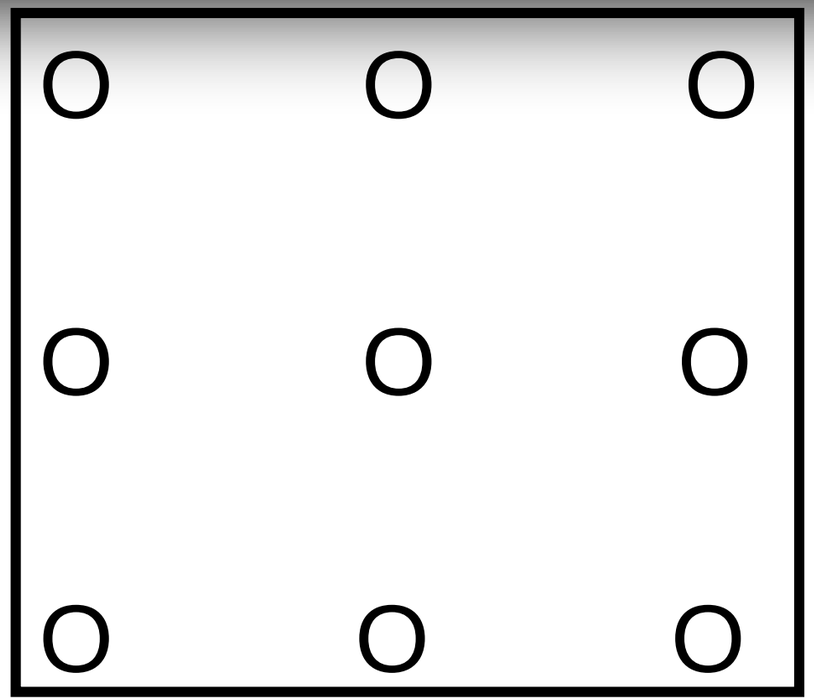
15' Series with 27° Trajectory

Nozzle	Pressure psi	Radius ft.	GPM	Precip. in/h	Precip. in/h
IPN-15F	20	13	2.85	1.63	1.89
	30	15	3.60	1.55	1.79
	40	16	4.20	1.59	1.84
	50	16	4.58	1.73	2.00
IPN-15TQ	20	13	2.10	1.61	1.85
	30	15	2.60	1.49	1.72
	40	16	3.00	1.61	1.86
	50	16	3.40	1.72	1.98
IPN-15TT	20	14	1.78	1.38	1.59
	30	15	2.20	1.42	1.64
	40	16	2.66	1.51	1.74
	50	16	2.84	1.61	1.86
IPN-15H	20	13	1.37	1.55	1.79
	30	15	1.65	1.44	1.66
	40	16	2.02	1.53	1.77
	50	16	2.14	1.62	1.87
IPN-15T	20	14	0.95	1.52	1.75
	30	15	1.10	1.42	1.64
	40	16	1.30	1.57	1.82
	50	16	1.45	1.75	2.03
IPN-15Q	20	14	0.68	1.34	1.55
	30	15	0.85	1.46	1.69
	40	16	1.04	1.57	1.82
	50	16	1.23	1.86	2.15

Practice

Rules of three:

1) 14gpm
2) 15gpm
3) 18gpm



96.3X14.83=1,309.68

30X30 = 900 =1.59

.17

1.59 = .107X60 = 7min

Or 10 with SM

New Run time

1) PR

2) Run Time

New flow 14.83gpm

15 Series HE-VAN

25° Trajectory

Nozzle	Pressure psi	Radius ft.	Flow gpm	Precip In/h
360° Arc	15	11	2.62	2.08
	20	12	3.02	2.02
	25	14	3.38	1.66
	30	15	3.70	1.58
270° Arc	15	11	1.96	2.08
	20	12	2.27	2.02
	25	14	2.53	1.66
	30	15	2.78	1.58
180° Arc	15	11	1.31	2.08
	20	12	1.51	2.02
	25	14	1.69	1.66
	30	15	1.85	1.58
90° Arc	15	11	0.65	2.08
	20	12	0.76	2.02
	25	14	0.84	1.66
	30	15	0.93	1.58

Courtesy of Rainbird Irrigation

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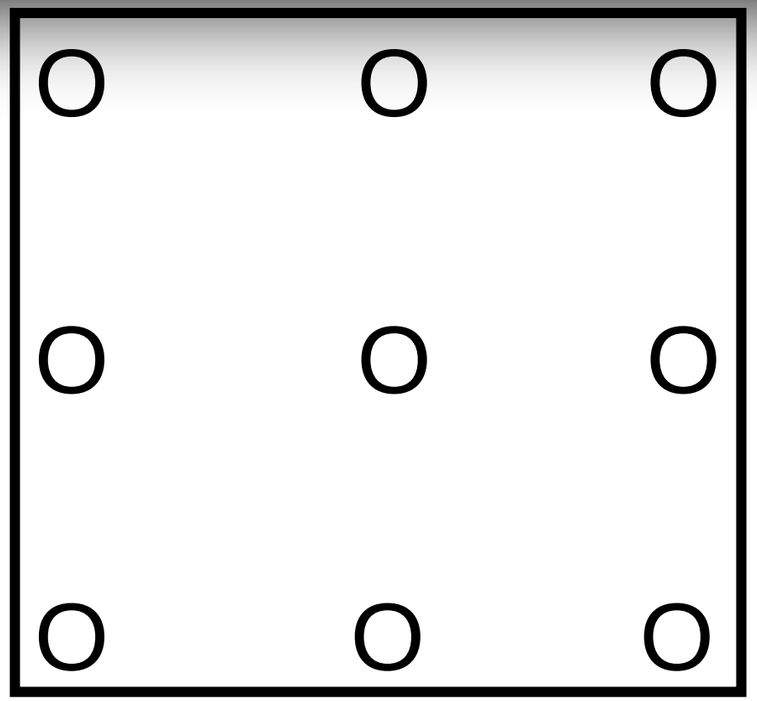
Practice

Rules of three:

1) 14gpm
2) 15gpm
3) 18gpm



96.3X3.32=319.72

30X30 = 900 =.36

.17

0.36 = .47X60 = 28min

Or 41 with SM

New Run time

1) PR
2) Run Time

New flow 3.32gpm

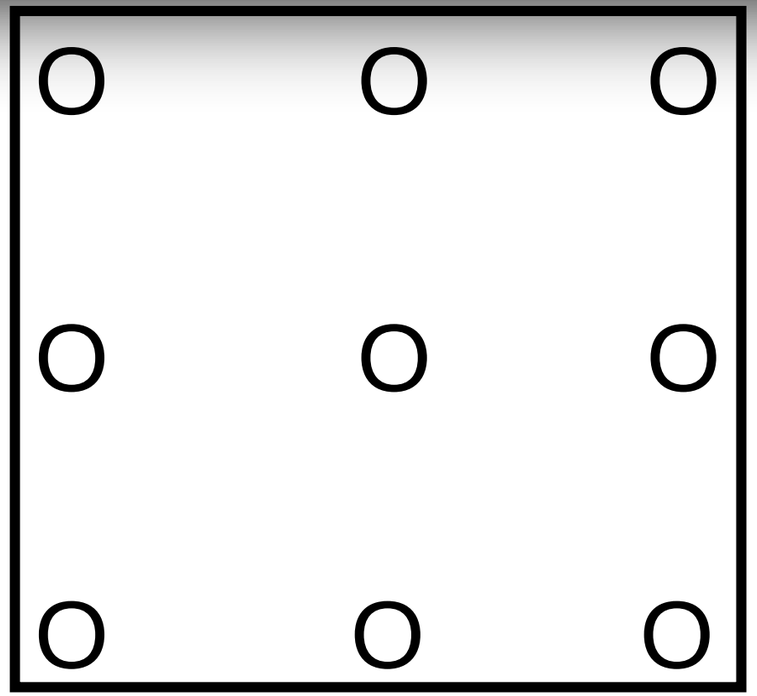
Arc	Pressure			Radius	Flow		Precip in/hr	
	PSI			ft	GPM	GPH	■	▲
90°	25			...	...	...	...	...
	30			12	0.16	9.6	0.43	0.50
	35			13	0.18	10.8	0.40	0.46
	40			14	0.19	11.4	0.39	0.45
	45			14	0.20	12.0	0.39	0.45
	50			14	0.21	12.6	0.38	0.43
	55			15	0.22	13.2	0.37	0.43
180°	25			...	...	...	...	...
	30			12	0.32	19.2	0.43	0.50
	35			13	0.35	21.0	0.40	0.46
	40			14	0.43	25.8	0.39	0.45
	45			14	0.40	24.0	0.39	0.45
	50			14	0.41	24.6	0.38	0.43
360°	25			...	...	...	...	...
	30			12	0.65	39.0	0.43	0.50
	35			13	0.71	42.6	0.40	0.47
	40			14	0.75	45.0	0.39	0.46
	45			14	0.80	48.0	0.39	0.45
	50			14	0.84	50.4	0.38	0.44
	55			15	0.87	52.2	0.37	0.43

Courtesy of Hunter Industries

Practice

Rules of three:

1) 14gpm
2) 15gpm
3) 18gpm



96.3X8.27=796.4

30X30 = 900 =0.88

.17

0.88 = .193X60 = 12min

Or 17 with SM

New Run time

1) PR
2) Run Time

New flow 8.27gpm

R13-18 Series (Black)

Arc	Pressure psi	Radius* ft.	Flow gpm	■ Precip In/h	▲ Precip In/h
R13-18F	20	13	1.31	0.75	0.86
	25	14	1.46	0.67	0.77
	30	16	1.60	0.61	0.70
	35	16	1.73	0.61	0.70
	40	17	1.85	0.61	0.70
	45	18	1.96	0.61	0.70
	50	18	2.07	0.61	0.70
	55	18	2.17	0.61	0.70
R13-18H	20	13	0.65	0.75	0.86
	25	14	0.73	0.67	0.77
	30	16	0.80	0.61	0.70
	35	16	0.86	0.61	0.70
	40	17	0.92	0.61	0.70
	45	18	0.98	0.61	0.70
	50	18	1.03	0.61	0.70
	55	18	1.08	0.61	0.70
R13-18T	20	13	0.44	0.75	0.86
	25	14	0.49	0.67	0.77
	30	16	0.53	0.61	0.70
	35	16	0.58	0.61	0.70
	40	17	0.62	0.61	0.70
	45	18	0.65	0.61	0.70
	50	18	0.69	0.61	0.70
	55	18	0.72	0.61	0.70
R13-18Q	20	13	0.33	0.75	0.86
	25	14	0.37	0.67	0.77
	30	16	0.40	0.61	0.70
	35	16	0.43	0.61	0.70
	40	17	0.46	0.61	0.70
	45	18	0.49	0.61	0.70
	50	18	0.52	0.61	0.70
	55	18	0.54	0.61	0.70

Courtesy of Rainbird Irrigation

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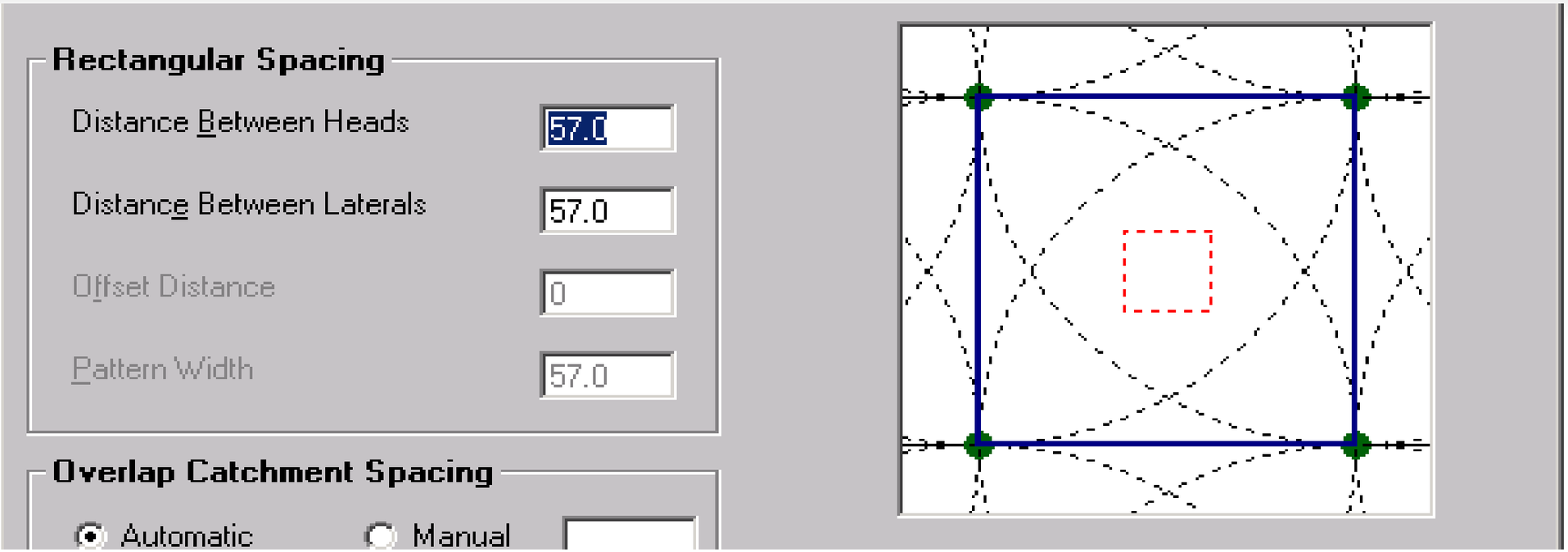
Space PRO Program



http://www.fresnostate.edu/jcast/cit/software/

"Promote Efficient Irrigation"

Uniformity Indicators- Profiles

Sprinkler Profiles- performance of an individual sprinkler

A key tool in proper head spacing

“Promote Efficient Irrigation”

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“Promote Efficient Irrigation”

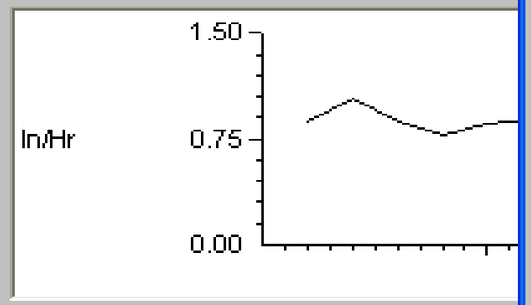
“Promote Efficient Irrigation”

SPACE Pro

File Units Window

Profiles - c:\program files\spac

Sprinkler	N
Rainbird R-50	R
Rainbird R-50	R
Rainbird R-50	R
Rainbird R-50	R
Rainbird R-50	R
Rainbird R-50	R
Rainbird R-50	R
Rainbird R-50	R
Rainbird R-50	R
Rainbird R-50	R



Sprinkler Test Information

Command

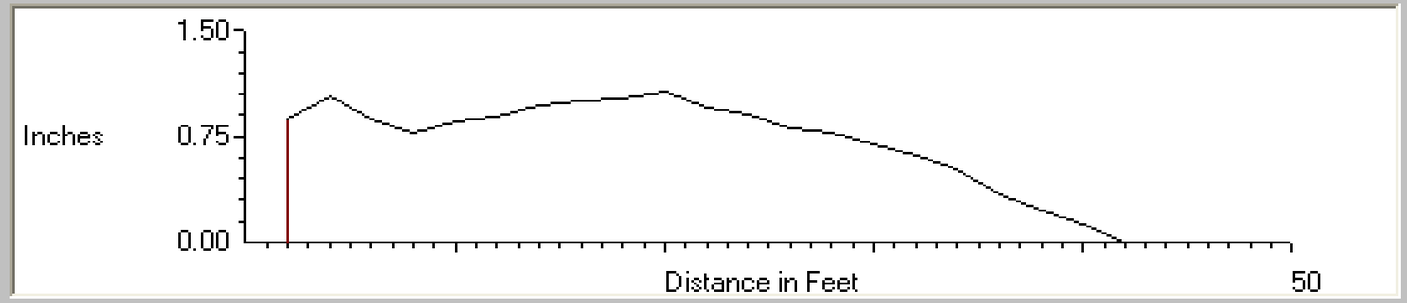
Sprinkler Name	Rainbird		
Sprinkler Model	R-50		
Nozzle	RC 6.0 H (36')		
Pressure (psi)	45	Riser Height (in)	0
Flow Rate (gpm)	7.10	Minutes/revolution	
Arc (Degrees)	180	Set Screw Setting	4
Test Duration (Min.)	60	Record Number	
Test Date (mm/dd/yy)	10/01/98	Test Time (hh:mm)	00:00
Comment			
Number of Catchments	20	Catchment Spacing	2

Catchment Data

2.0' = 0.873

2.0' =	0.873
4.0' =	1.030
6.0' =	0.873
8.0' =	0.774
10.0' =	0.860
12.0' =	0.892
14.0' =	0.965
16.0' =	1.004
18.0' =	1.017
20.0' =	1.063

Insert Delete



Uniformity Indicators- Densograms

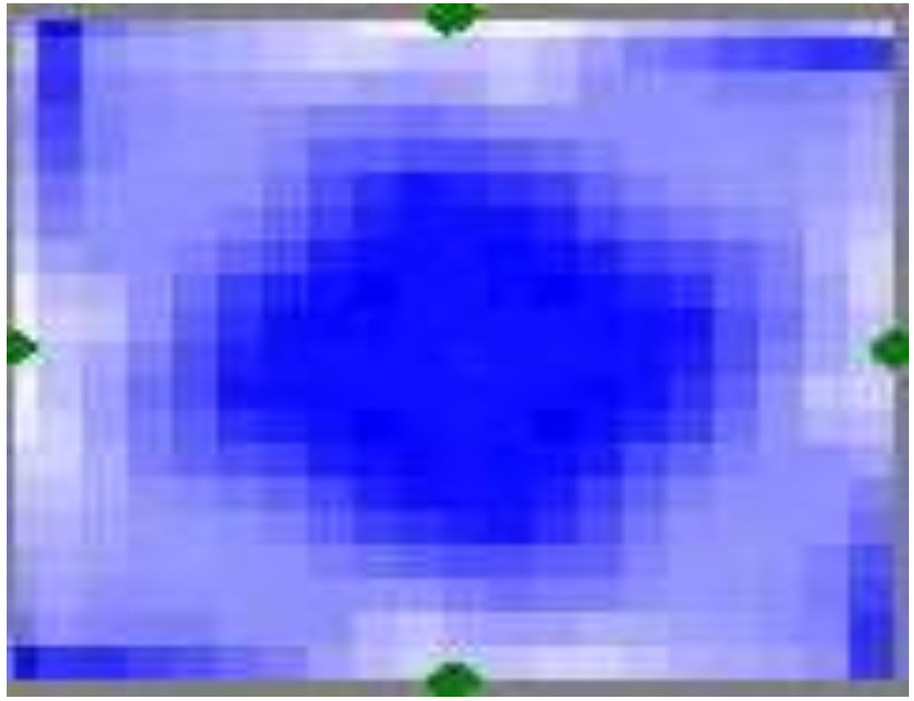
Easily understood and interpreted

Dark = Wet Light = Dry

Dry and wet areas:

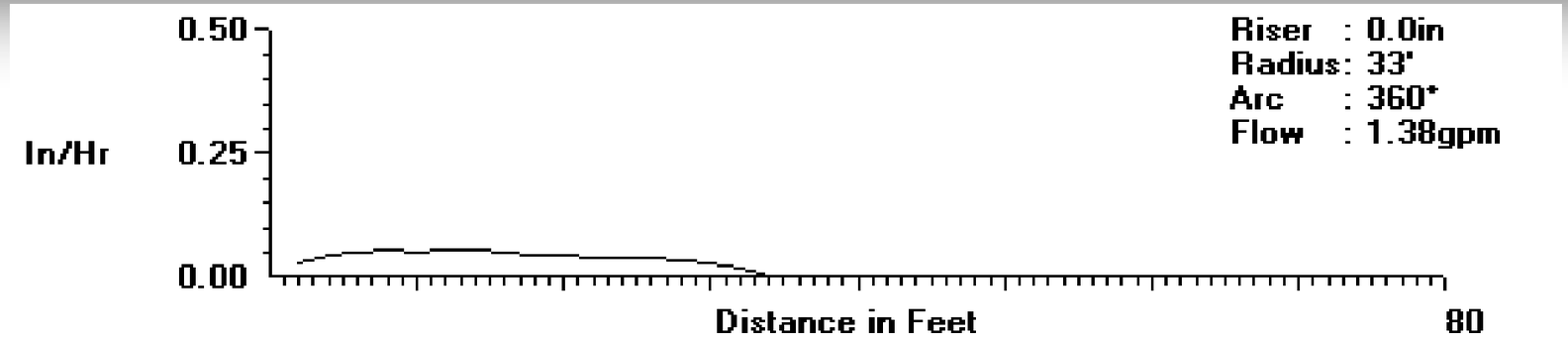
- *Location*
- *Size*
- *Shape*

Can be compared to field observed patterns



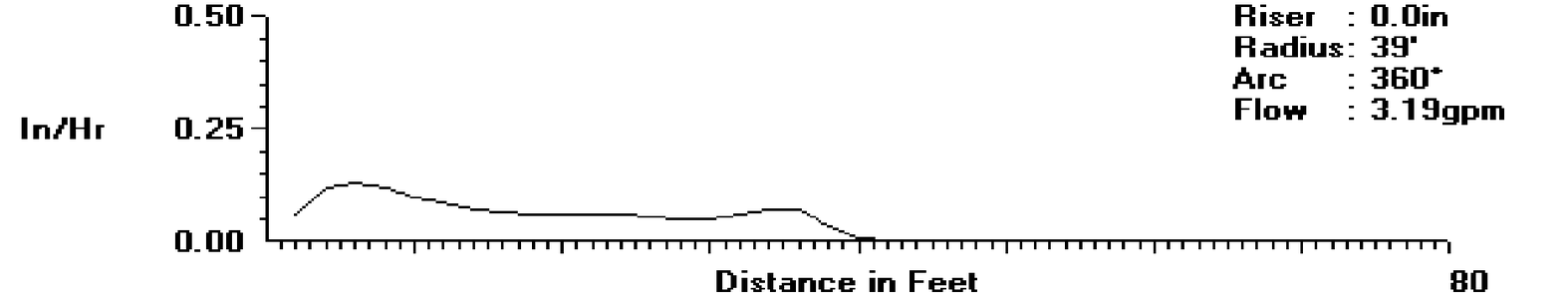
Q, H, F Nozzle Profiles for MPR

33’



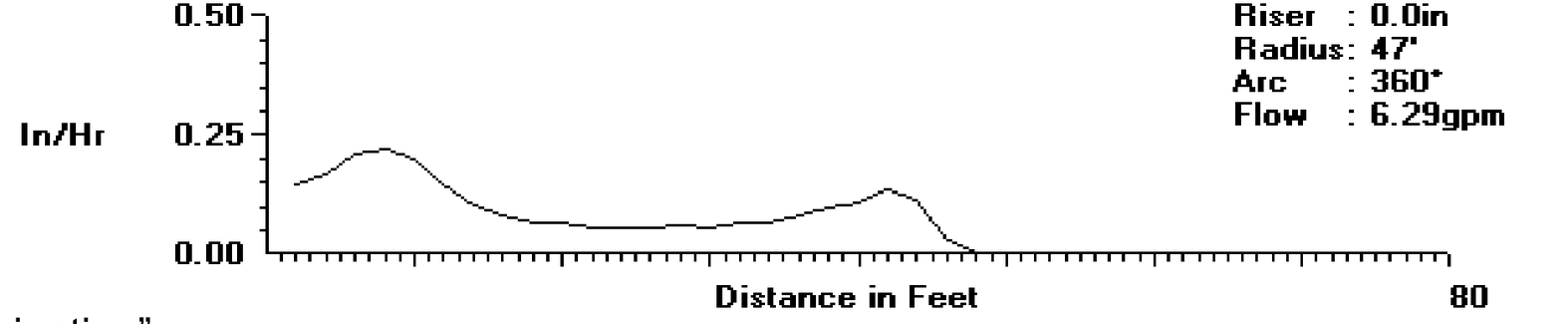
#4

39’



#7

47’



#10

“Promote Efficient Irrigation”

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Let’s look at spray heads!

“Promote Efficient Irrigation”

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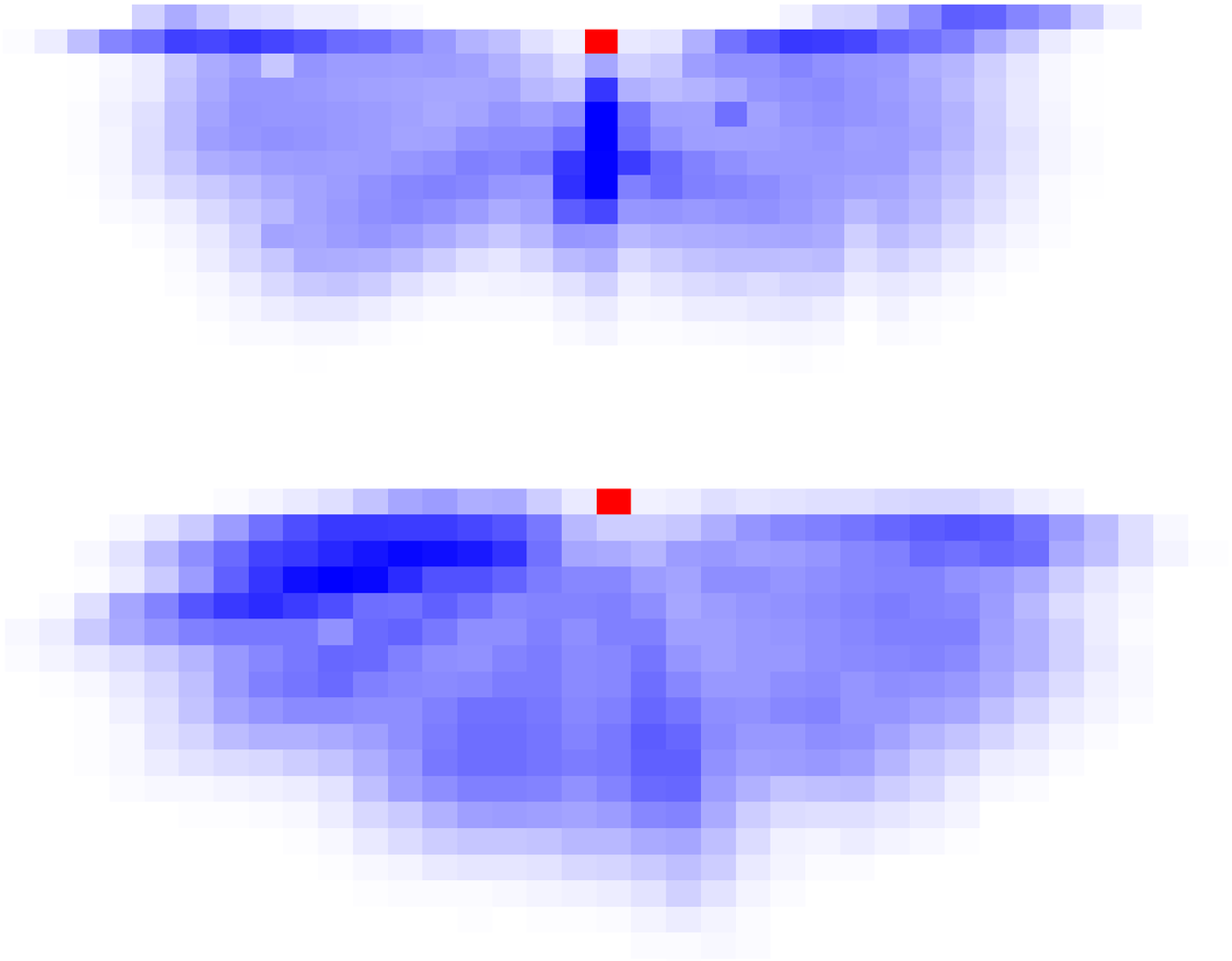


Grid patters from SPACE™

Possible Conclusions

Spray heads space @ 90% of radius

- 15’ sprays on 13.5’ centers

Rotor heads space @ 85% of radius

- 36’ radius throw, space on 30’ centers
- Don’t reduce radius of throw if possible

May improve system uniformity, but at higher cost and higher PR rates

Use SPACE™ to make your own conclusions

Quality Product and Installation

Low quality product is unlikely to perform well

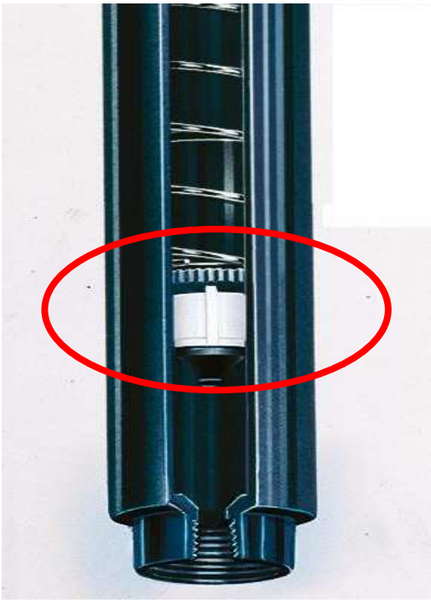
Low quality product will fail sooner

Installers using low quality product tend to install poorly designed and poorly installed systems

A “cheap” system cannot save water unless it is turned off!

COM – Check Valve

- Check Valves
  - Reduce potential for low head drainage
  - Reduce potential for air hammer



Potential Savings COM vs Non-COM

Small Zone (10’ x 50’ front lawn)

130’-1”Class 200 = 1 ft^3 or 7.481 gallons/cycle x 10 cycles/week

Potential Savings 74.81 gallons/week

Big Zone (60’ x 180’ commercial w/ gear-driven rotor)

540’-1” + 100’-2” Class 200 = 6.59 ft^3 or 49.28 gal./cycle x 10 cycles/week

Potential Savings 492.8 gallons/week

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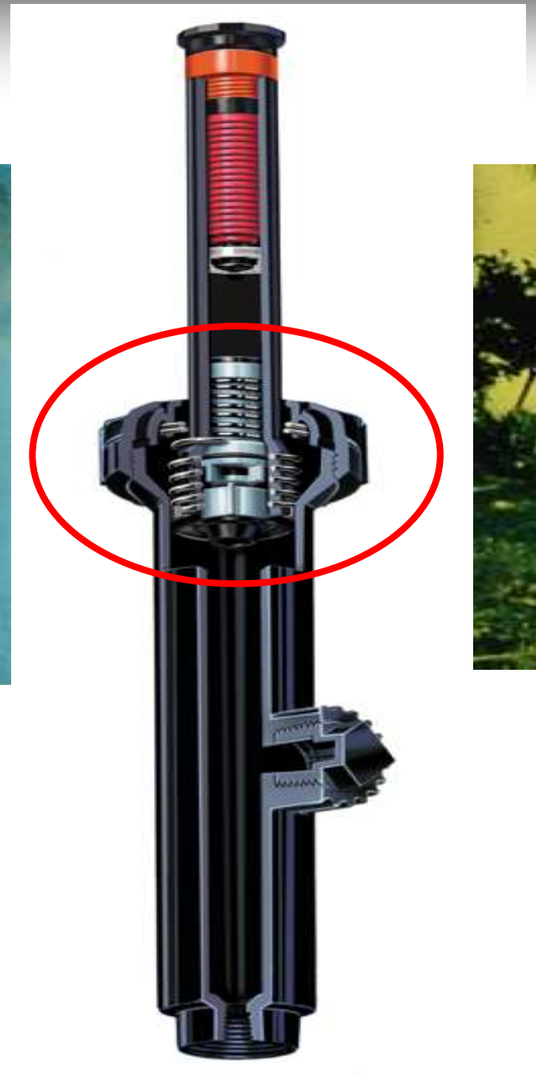
Sprayheads
PR - Pressure Regulation



<u>Alternative:</u>
PC nozzles

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Sprayheads
Effects of Pressure on Uniformity

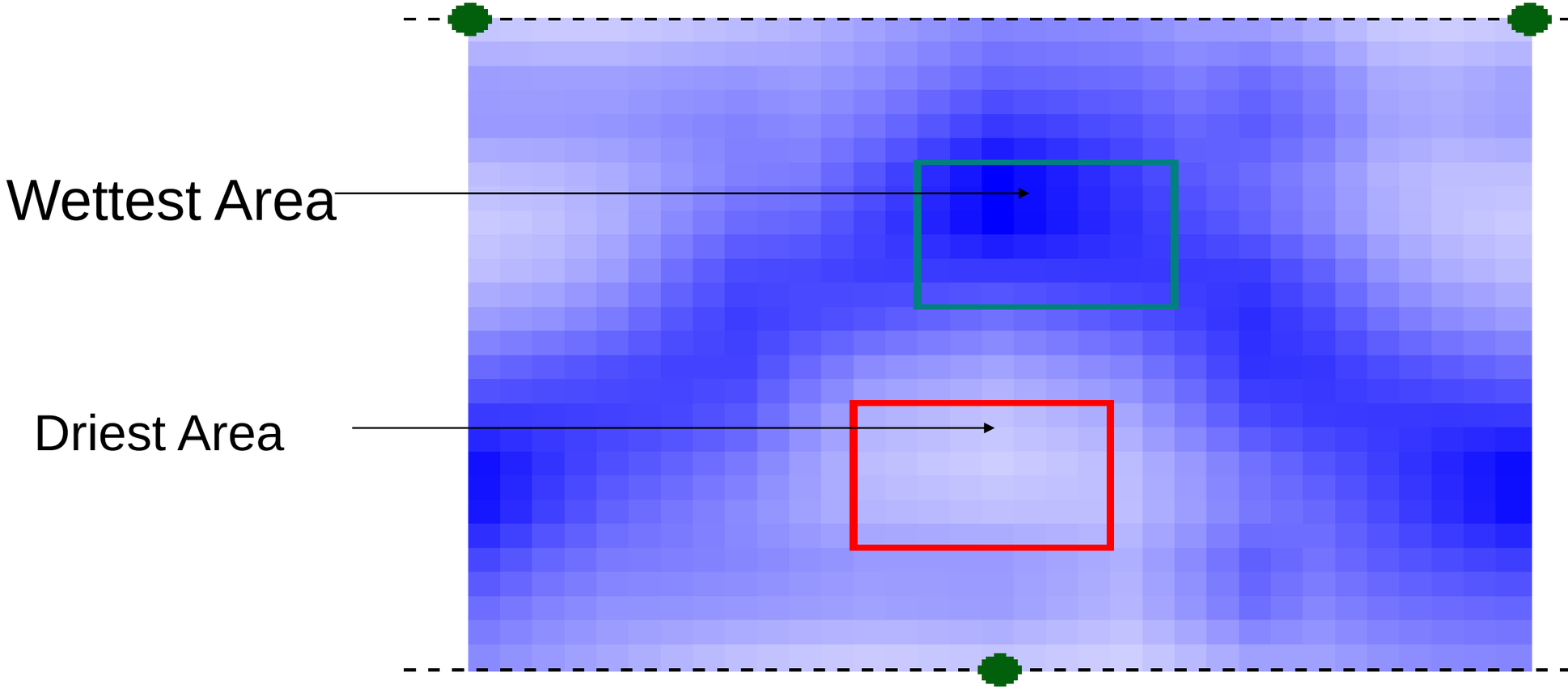
I-PRO 4" with 8H Nozzle at 60 PSI

Distribution Uniformity Evaluation – Triangular Layout

DU = 53%

CU = 67%

SC = 2.0



Sprayheads
Effects of Pressure on Uniformity

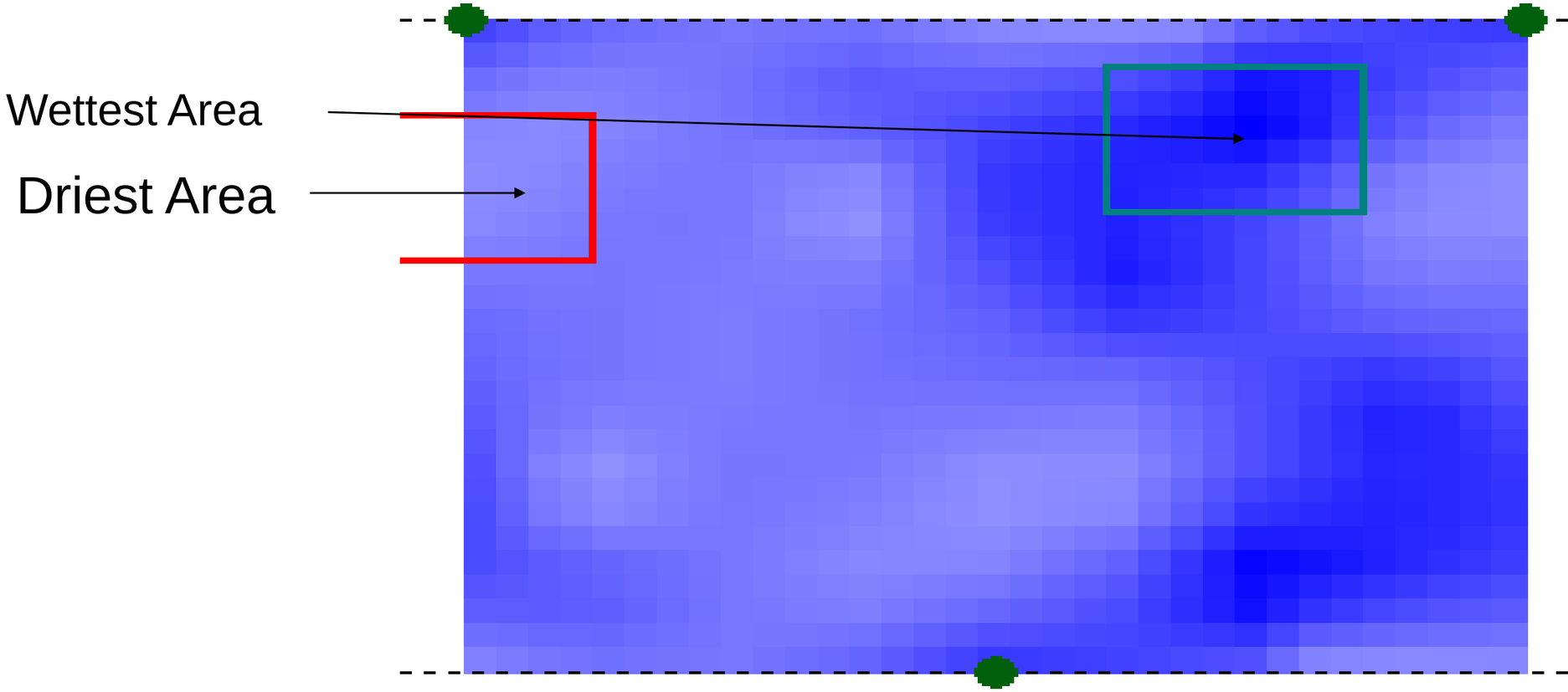
I-PRO 4" with 8H Nozzle at 30 PSI

Distribution Uniformity Evaluation – Triangular Layout

DU = 78%

CU = 82%

SC = 1.3



Potential Savings
Non-PR vs. PR

- 10’ x 50’ turf area. (Etc of 1.2”/wk.)
- Distribution Uniformity =

  Non-PR @ 60psi = 53%

  PR @ 30psi = 78%

Non PR (60psi) = 82 min./week x 10.32gpm = 846 Gallons

PR (30psi) = 58 min/week x 7.28gpm = 422 Gallons

424 gallons saved per week or 49% more efficient

The “Price” of Water

$648/acre foot (.002/gal)

$325,851/acre foot

$724,414/acre foot

$2.50/16 oz = $6.5 Million/acre foot

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Benefits of Turfgrass

Environmental

- Cools the Air
- Produces Oxygen
- Filters Air & Reduces Pollution
- Captures & Suppresses Dust
- Recharges & Filters Groundwater Supply
- Reduces Storm Water Runoff
- Controls Soil Erosion
- Retains and Sequesters Carbon
- Assists Decomposition of Pollutants
- Restores Soil Quality

Oxygen and Turfgrass

"The grass and trees along our country's interstate system produce enough oxygen to support 22 million people!"

"According to the Outdoor Power Equipment Institute the average lawn takes in 4 times more carbon than the mower used to maintain it produces.

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Benefits of Turfgrass

Community & Human Health

- Enhances Community Pride & Social Harmony
- Offers a Natural Playing Surface for Recreation
- Provides a Safe Surface & Reduces Injuries
- Promotes Outdoor Activity & Exercise
- Improves Physical & Mental Health
- Relieves Stress
- Lowers Allergy Related Problems
- Dissipates Heat & Cools the Environment
- Reduces Glare
- Diminishes Noise Pollution
- Minimizes Nuisance Pests
- Compliments Overall Landscaping
- Preserves Natural Wildlife Habitat

www.lawninstitute.org

www.turfgrasssod.org

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“The kind of thinking today
that is preparing us for business tomorrow”

Thank You!

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