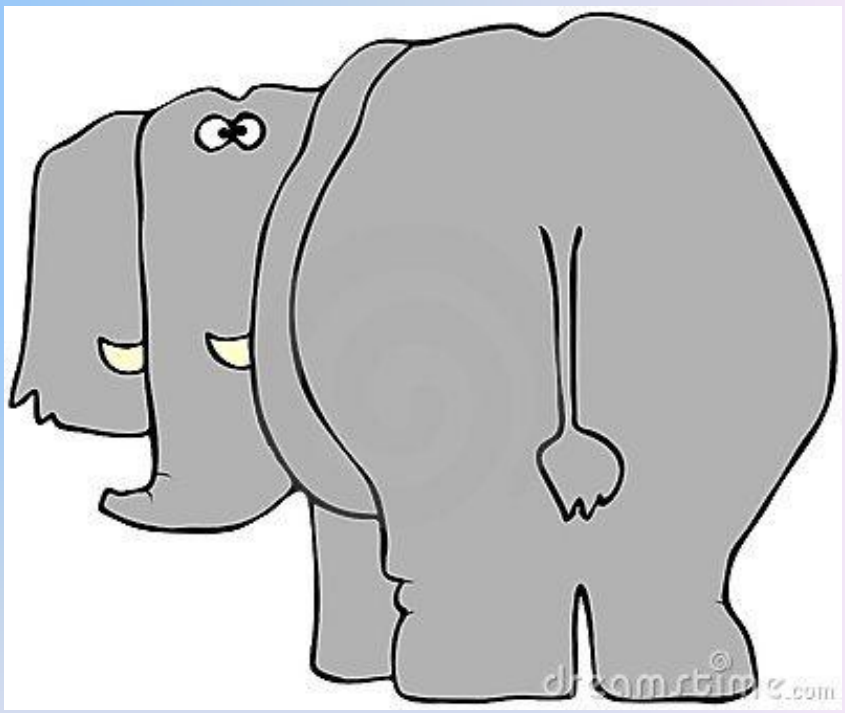
Irrigation Scheduling Strategies

For Landscape Water Managers

AUDIENCE MAKE-UP

TROUBLE!

Does This Make My Water Butt Look Big?



- Our ***Water Footprint*** is now a concern just as is our Carbon Footprint.
- Leadership in Energy and Environmental Design (LEED) standards are for Design as well as Maintenance and Operations.
- We’re not in Kansas anymore, Dorothy!

9. Who does the scheduling of your irrigation systems?

Create Chart | Download

	Response Percent	Response Count
Irrigation Crew	50.0%	9
Supervisor	55.6%	10
Crew Leader	5.6%	1
Manager	27.8%	5
Other	5.6%	1
answered question		18
skipped question		0

10. Are your irrigation schedules changed at least seasonally?

Create Chart | Download

	Response Percent	Response Count
Yes, we do it manually	83.3%	15
Yes, we have Smart Controllers	16.7%	3
No	0.0%	0
answered question		18
skipped question		0

We Must Now All Be

Landscape Water Managers

Not just irrigators or maintenance staff!

Texas Administrative Code, Part 1, Chapter 344

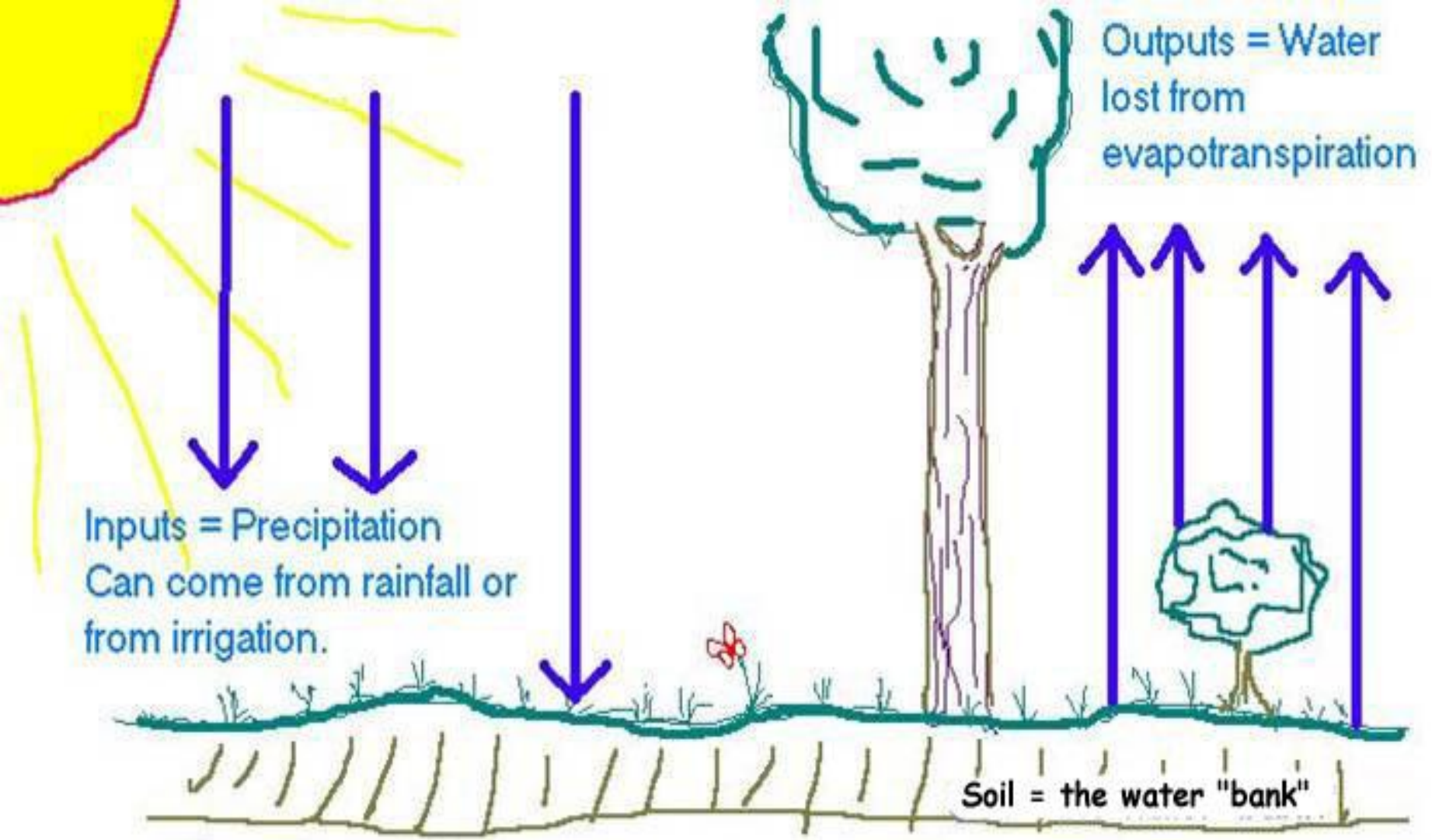
- *§344.63.Completion of Irrigation System Installation.*
- Upon completion of the irrigation system, the irrigator or irrigation technician who provided supervision for the on-site installation shall be required to complete four items:
- (2) The maintenance checklist on which the irrigator or irrigation technician shall obtain the signature of the irrigation system's owner or owner's representative and shall sign, date, and seal the checklist. If the irrigation system's owner or owner's representative is unwilling or unable to sign the maintenance checklist, the irrigator shall note the time and date of the refusal on the irrigation system's owner or owner's representative's signature line. The irrigation system owner or owner's representative will be given the original maintenance checklist and a duplicate copy of the maintenance checklist shall be maintained by the irrigator. **The items on the maintenance checklist shall include but are not limited to:**
- **B a seasonal (spring, summer, fall, winter) watering schedule based on either current/real time evapotranspiration or monthly historical reference evapotranspiration (historical ET) data, monthly effective rainfall estimates, plant landscape coefficient factors, and site factors**;

Goals of Effective Landscape Water Management

- Apply the right amount of water
- At the right rate
- At the right time
- With good uniformity

How Much Water to Apply?

- Standard is to replace EVAPOTRANSPIRATION lost
- Measured in inches just like a rain guage



Evaporation + Transpiration = Evapotranspiration = ET

Factors which influence ET include solar radiation, wind, temperature, relative humidity and soil moisture content.

Water Requirement Formulas:

Trouble!

Without Rainfall

$$WR = \frac{ET_o \times K_L \times A}{DU \times E_{WM} \times C_u}$$

With Effective Rainfall

$$WR = \frac{((ET_O \times K_L) - R_E) \times A}{DU \times E_{WM} \times C_u}$$

Where:

WR	=	Water Requirement
ET_O	=	Reference Evapotranspiration (inches per year)
K_L	=	Landscape Coefficient
A	=	Area (ft^2) or acres
Cu	=	Conversion Factor
DU	=	Distribution Uniformity
E_{wm}	=	Management Efficiency
R_E	=	Effective Rainfall

How Much Water to Apply?

- Two considerations, *how much was lost* and *how much is left*.
- Evapotranspiration is how much was lost
- Amount of ET lost can be determined by:
  - On site weather stations
  - On site SMART controllers
  - Manually looking up on Internet

Trouble may occur due to:

- Location of weather station, microclimates
- Quality of weather station
- Maintenance of weather station
- Cost/benefit for manually looking up on Internet, i.e., how much time will it take?
- Reliability of SMART controllers
  - NOT set it and forget it!

SMART CONTROLLERS

- In the 2010 study (the most recent study available), which spanned 238 days of eight controllers and six zones in a virtual landscape, only 15 of the 48 zones were within +/- 20 percent of the recommendations of the Texas ET Network.
- http://texaset.tamu.edu/

SMART CONTROLLERS

- Broken down by season:
- 15 of 48 zones were within +/- 20 percent in the spring
- 10 of 48 zones were within +/- 20 percent in the summer
- 14 of 48 zones were within +/- 20 percent in the fall.

SMART CONTROLLERS

- You can access the complete reviews of all Texas A&M's smart controller studies at

http://itc.tamu.edu/smart.php

How Much Water to Apply

- Can also be determined by the SOIL , *how much is left*
- Water Holding Capacity of the soil is the “bank”
- When moisture is depleted to the point of needing to be replaced (Maximum Allowable Depletion or MAD), its time to irrigate
- Determined by:
  - Soil Type
  - Bulk Density (mass/weight per unit of volume)
  - Porosity
- Irrigation *frequency* also determined by Root System of Plant
  - Root Depth
  - Root Biomass
- ***ET alone will not account for these***

How Much Water to Apply?

- Soil Moisture Sensors
  - Soil moisture sensors measure what is actually going on (moisture available) at a given location
  - Can be used to prevent irrigation from running before the soil reaches a specified level of moisture depletion
- Rain sensors shut off irrigation after a rainfall event and may dry out prematurely if windy but soil moisture sensors are a direct measurement of moisture conditions where it counts… at the root zone!

Increased Bulk Density Restricts Root Growth

Table 1. General relationship of soil bulk density to root growth based on soil texture.

Soil Texture	Ideal bulk densities for plant growth (g/cm3)	Bulk densities that restrict root growth (g/cm3)
Sandy	< 1.60	> 1.80
Silty	< 1.40	> 1.65
Clayey	< 1.10	> 1.47

http://soilquality.org/indicators/bulk_density.html

How Much Water to Apply (back to ET)

- After determining how much water to apply based on replacing ET lost (inches) and implementing your plan, ***monitor your results to see if your plan is working!***
  - Measure irrigated area by zone or at least by system
  - Meter water used
  - 1 acre inch = 27,154 gallons
  - If you needed to replace 1” of water over ¼ acre, that would require 25% of 27,154 or 6,789 gallons

Goals of Effective Landscape Water Management

- Apply the right amount of water
- At the right rate
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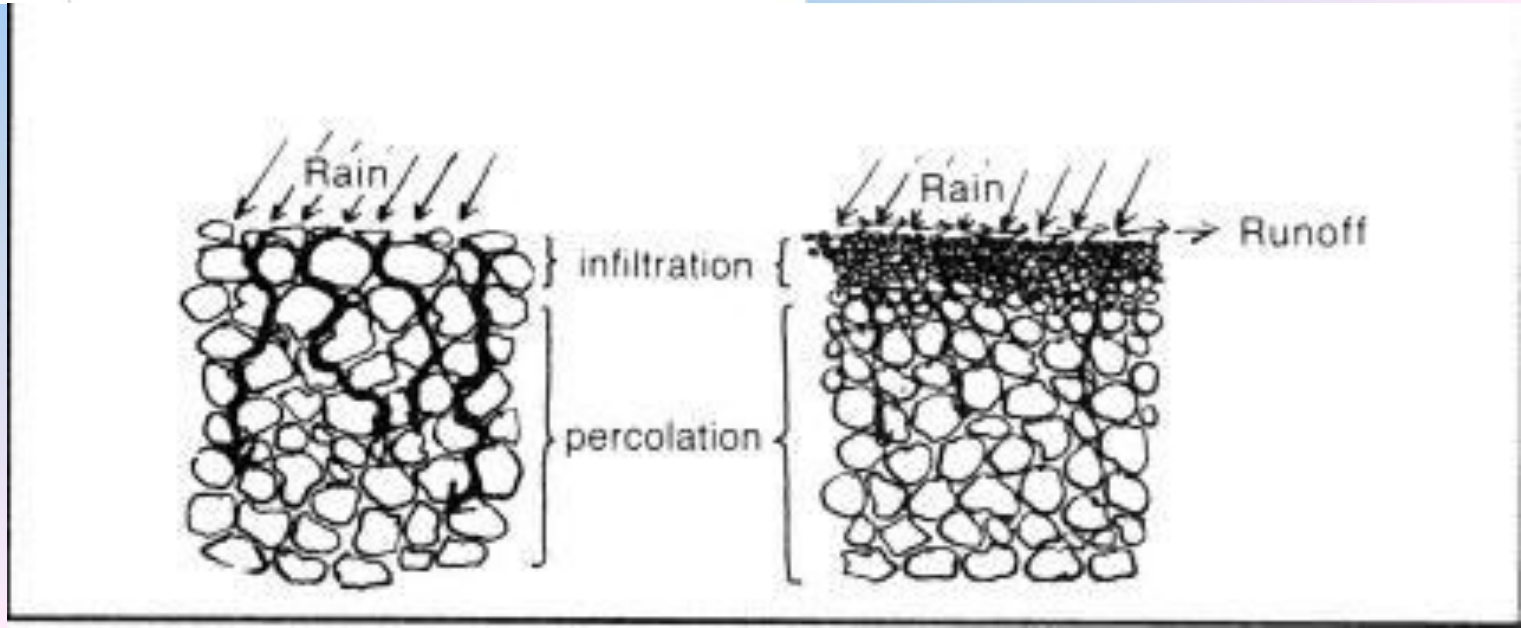
Trouble!

- **RUNOFF!**
- Irrigation runoff due to slope.
- Irrigation runoff due to the soil already being saturated.
  - The more shallow the soil, the quicker runoff occurs (soil depth minimums for new construction).
- ***Irrigation runoff due to rate of precipitation exceeding rate of infiltration, percolation***.
- Combination of these factors
- May be more challenging with mandated watering days.

Infiltration and Percolation

Soil Type	Infiltration Rate (in/hr)
Sand	> 1.2
Sandy Loam	.8 - 1.2
Loam	0.4 - 0.8
Clay Loam	0.2 - 0.4
Clay	.04 - .0.2

Dig a hole!



Precipitation Rate (PR)

- PR is a measure of how much water is hitting the ground in a given period of time
- Measured in inches per hour (in/hr)
- Can be determined from:
  - Manufacturer's catalog
  - Calculating PR
  - Direct measure of PR from an audit in the field

Find PR in Manufacturer's Catalog

SMITHCO

Performance Data

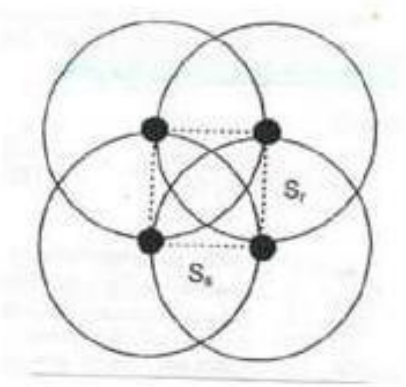
Nozzle	Pressure PSI	Radius ft.	Flow GPM	Precip in/hr ■	Precip in/hr ▲
40	40	45'	7.0	0.67	0.77
	50	46'	8.0	0.73	0.84
	60	46'	8.5	0.77	0.89
41	50	50'	10.2	0.79	0.91
	60	51'	11.1	0.82	0.95
	70	52'	12.1	0.86	0.99
	80	53'	13.0	0.89	1.03
42	50	51'	11.0	0.81	0.94
	60	53'	12.3	0.84	0.97
	70	55'	13.1	0.83	0.96
	80	56'	13.9	0.85	0.99
43	50	56'	13.5	0.83	0.96
	60	57'	15.1	0.89	1.03
	70	59'	16.1	0.89	1.03
	80	61'	17.5	0.91	1.05
44	60	63'	20.0	0.97	1.12
	70	65'	21.8	0.99	1.15
	80	66'	23.4	1.03	1.19
	90	67'	24.9	1.07	1.23
45	60	66'	22.7	1.00	1.16
	70	68'	24.7	1.03	1.19
	80	69'	26.4	1.07	1.23
	90	70'	28.2	1.11	1.28

Calculate PR

Precipitation Rate Equations

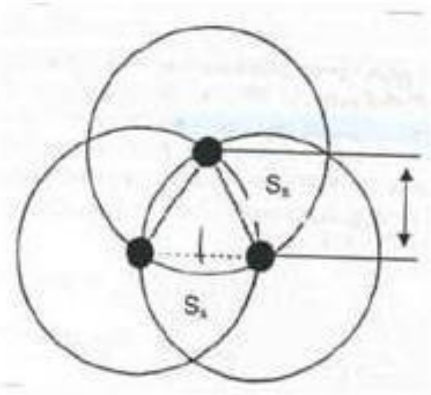
Square or Rectangular Spacing

$$PR = \frac{96.3 \times Q_{gpm}}{S_s \times S_r}$$



Equilateral Triangular Spacing

$$PR = \frac{96.3 \times Q_{gpm}}{S_s^2 \times 0.866}$$



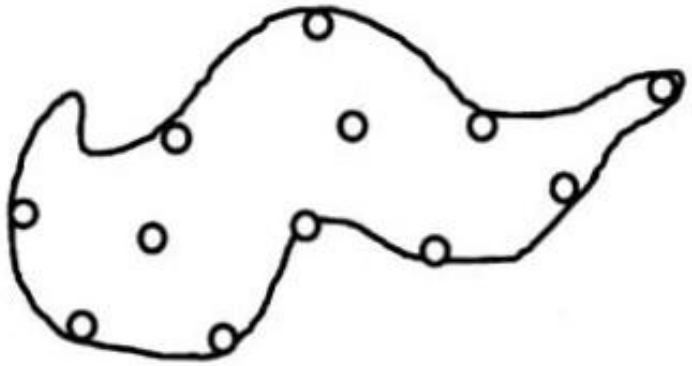
Q is flow (gpm) for one full circle head.

Calculate PR

Precipitation Rate Formula for Irregular Shaped Areas

For this application you would simply add up the gpm from all of the heads in a given area (assuming all water stays in the area) and estimate the total square footage for the entire area being watered. The formula would then be:

$$PR = \frac{96.3 \times Q_{gpm}}{A}$$



Direct Field Measurement of PR

SWT begins irrigation audits to conserve water

A new program being implemented at Southwest Texas State University is aimed at saving water used for landscape irrigation.

SWT has begun a program of systematic campuswide irrigation audits designed to further promote water conservation and more efficient use of water resources.

At regular intervals, SWT grounds maintenance personnel will test sprinkler systems at different campus locations using water catch-cans placed in grid patterns.

"These tests will give us an overall picture of how efficient each particular irrigation system is, and allow us to make necessary modifications," said Brad Smith, director of grounds operations at SWT.

Data gathered from the audits is fed into a computer program that can, when used in conjunction with evapotranspiration data for this region, help SWT workers determine ideal watering schedules.

The Edwards Aquifer Authority has asked water suppliers to develop a set of "best management practices," and Smith said the irrigation audits are one response to that request.

In addition, SWT is expanding its use of xeriscaping, a landscaping practice that relies on native or well adapted plants that require less water and pesticides.

The irrigation audits will require the operation of some sprinkler systems during daylight hours in the summer, but Smith said signs will be posted at audit locations to inform the public that an audit is in progress.

"In the long run, this will help protect our valuable water resources," he said.

Setting up the system

Southwest Texas State University grounds maintenance employees Adam DeLeon (left) and Albert Gomez set catch-cups as part of an irrigation audit.

Applying Water at Right Rate

- Once you know the characteristics of your soil and site, *match your irrigation design and operation so as not to exceed the infiltration of water into the soil*
- *VOILA*, NO RUNOFF!
- Cycle and soak
- Special attention to zones along curbs and hardscapes.

Subsurface Drip Installation

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Goals of Effective Landscape Water Management

- Apply the right amount of water
- At the right rate
- At the right time
- With good uniformity

When to Apply

- May be limited by local ordinance or regulations
- Frequency should be determined by plant available water including:
  - Root depth and, to some extent, root biomass
  - Bulk density and porosity of the soil
  - Maximum allowable depletion of soil moisture
- ET alone will not account for soil moisture content directly but is still the common recommended basis for irrigation scheduling.

Scheduling

- Go over handout at the end.

Goals of Effective Landscape Water Management

- Apply the right amount of water
- At the right rate
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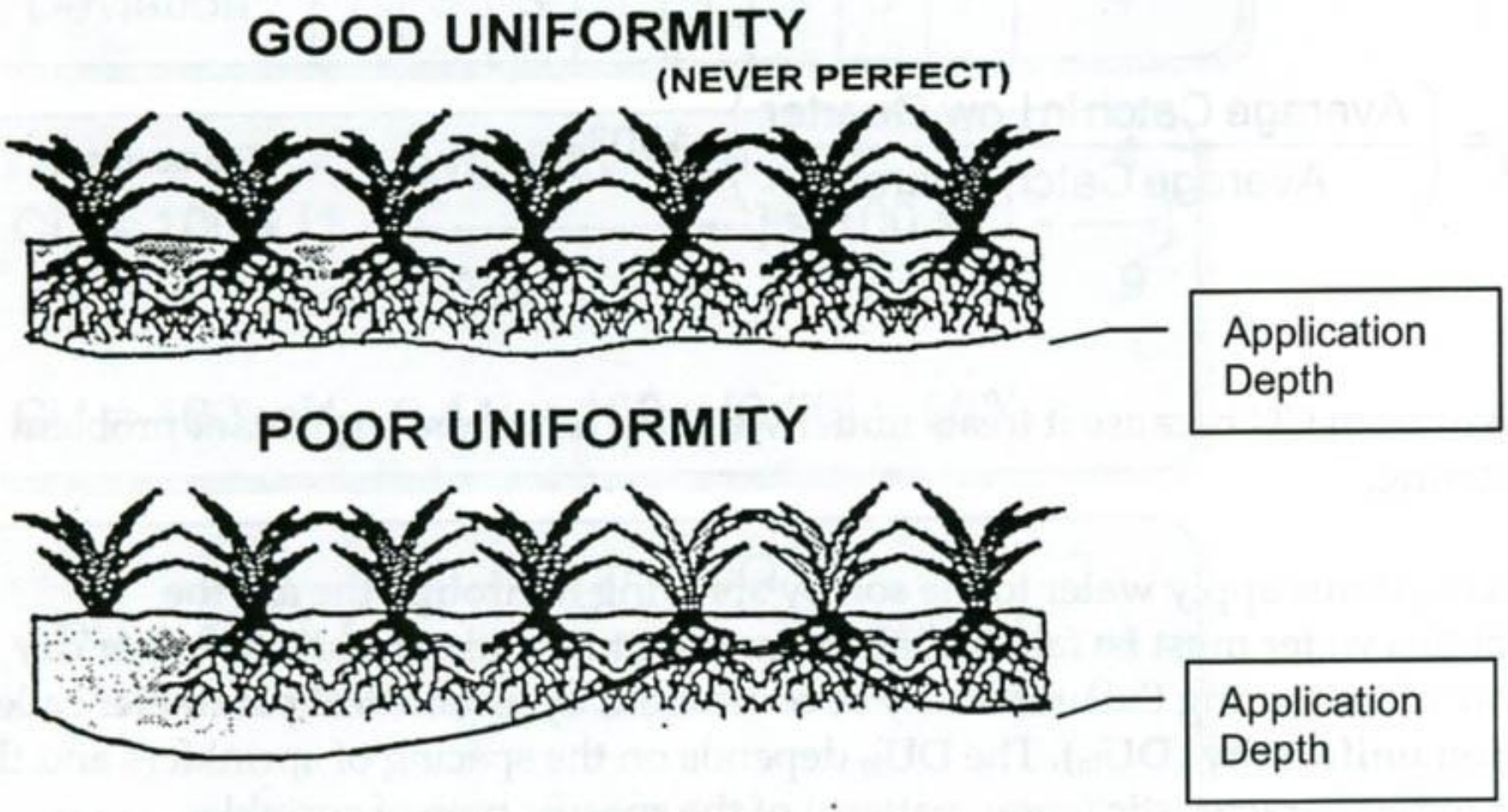
Distribution Uniformity (DU)

- Best determined by direct measurement as a part of an irrigation audit.
- Never perfect (100%)
  - Rotors typically 70% - 75%
  - Sprays typically 50% to 70%
  - Drip in the high 90% range!
- Important because we tend to irrigate to the dry spot!
- One of the bigger sources of wasted water in landscape irrigation is poor DU!

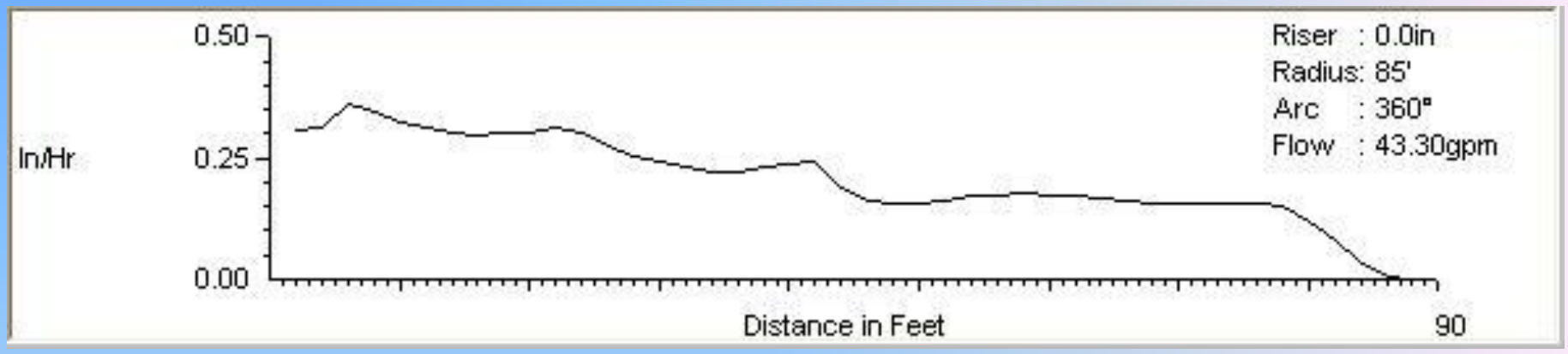
Distribution Uniformity (DU)

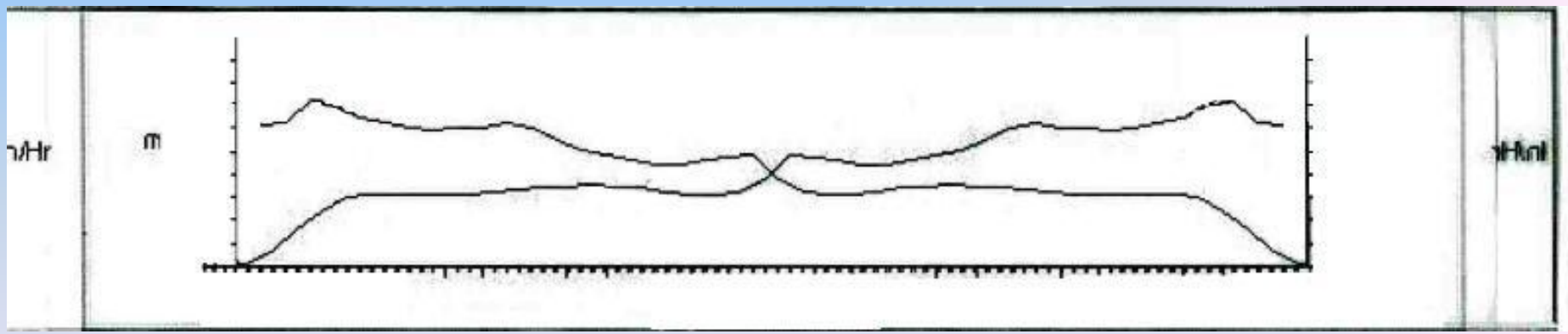


Distribution Uniformity (DU)

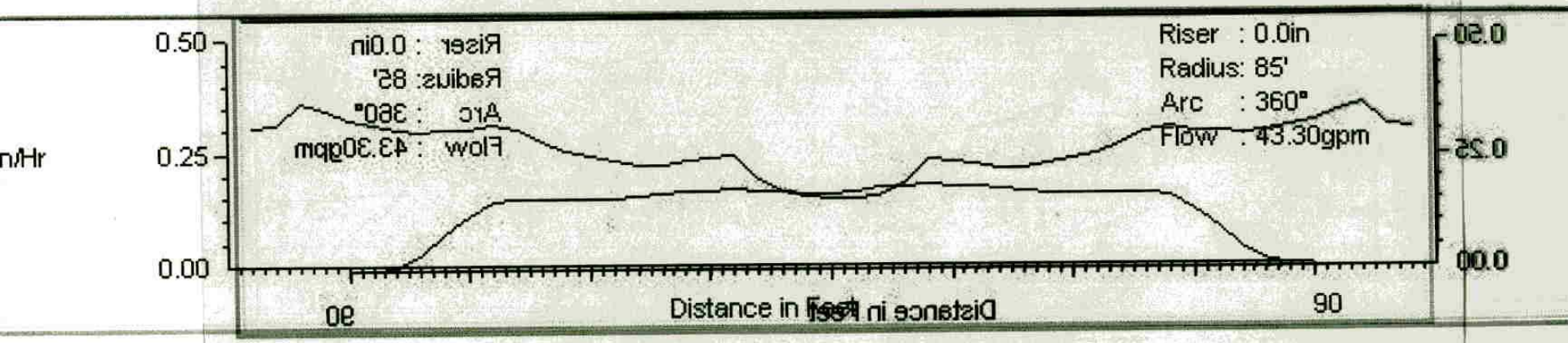
- Determined by:
  - Head spacing
  - Pressure (use pressure regulators!)
    - We design for “enough” pressure but should also look for TOO MUCH pressure!
  - Nozzle selection for rotors
  - Wind
  - Hydraulics

DU Greatly Impacted by Head Spacing





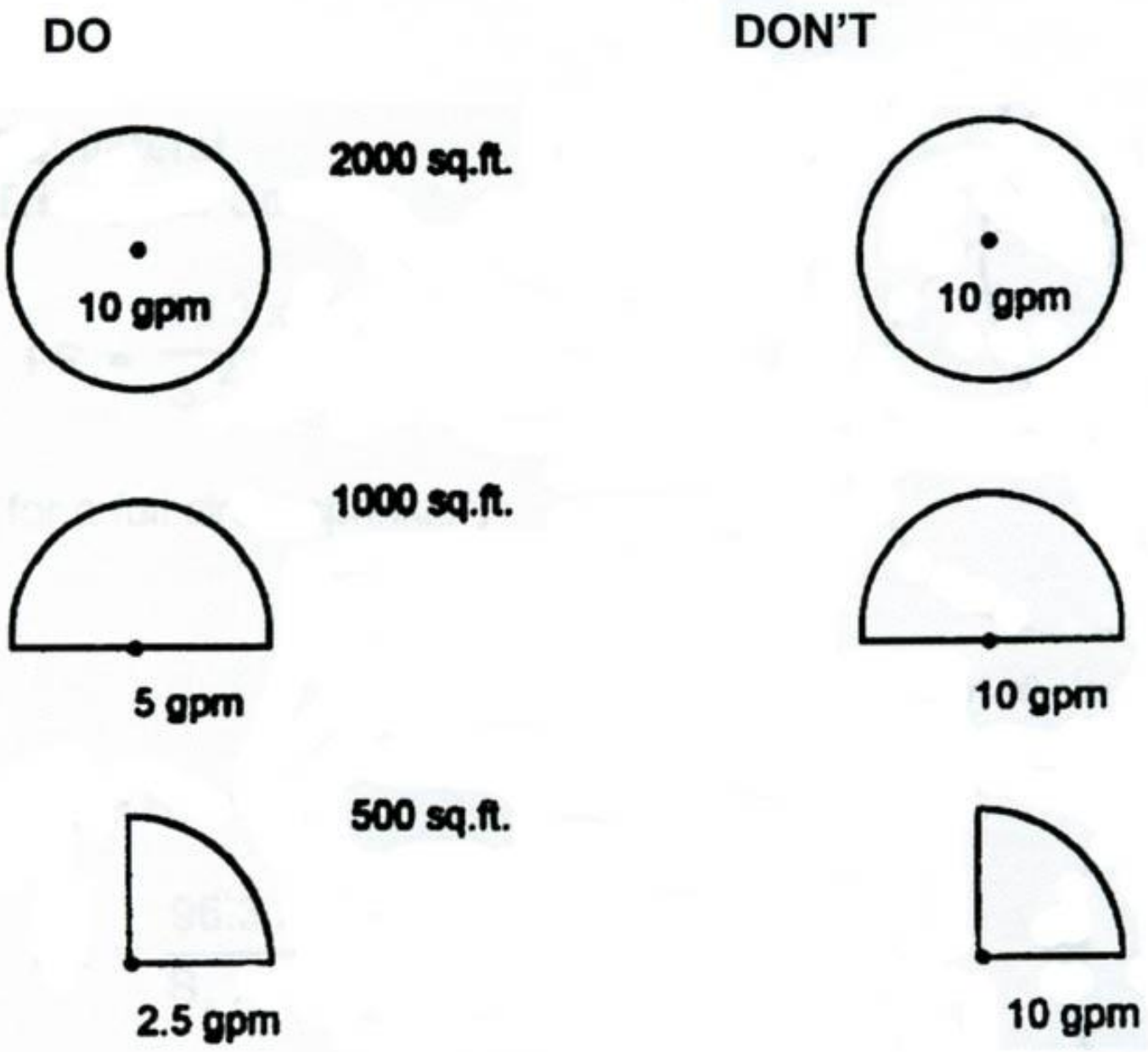
Trouble!

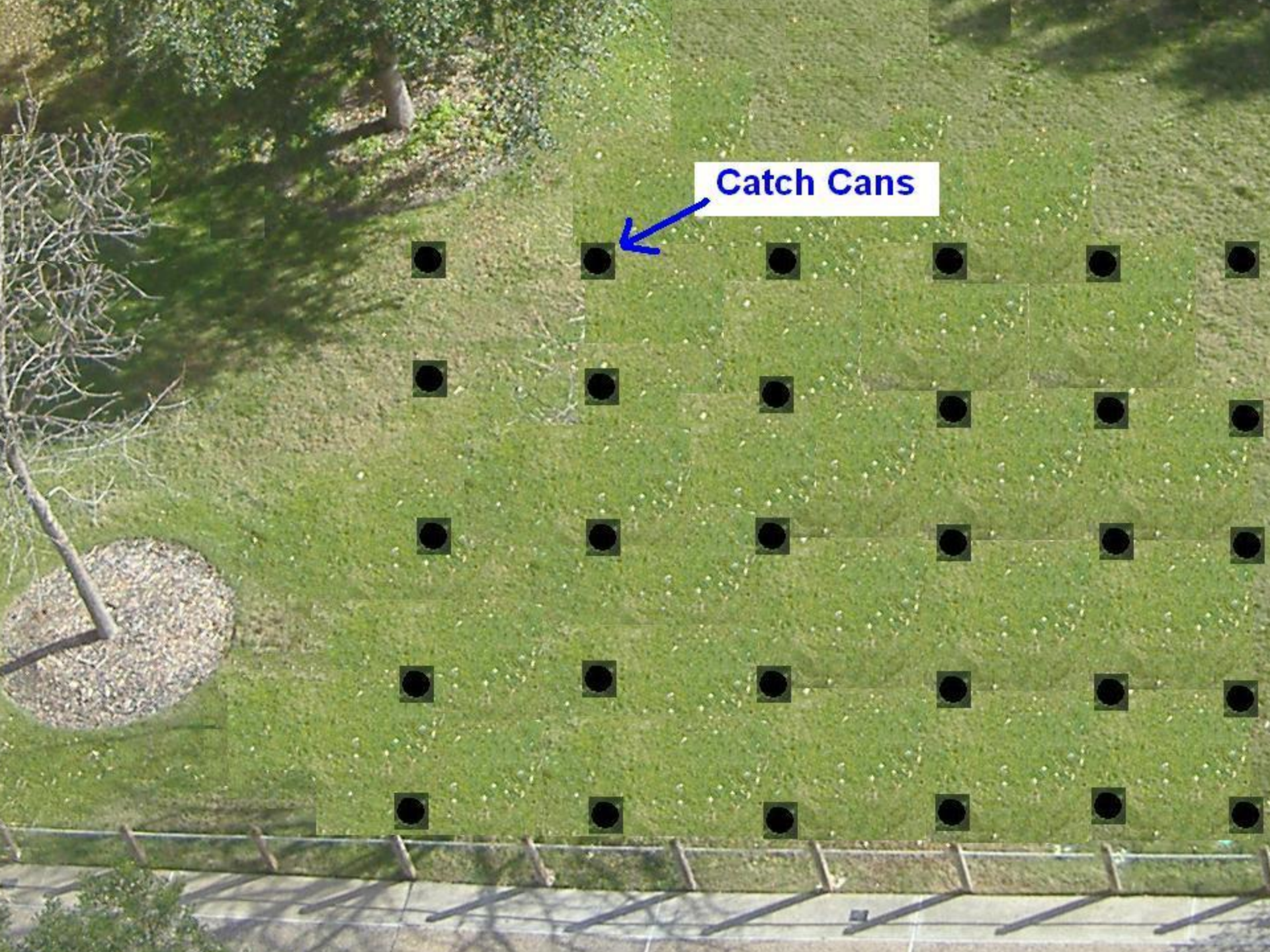

Riser : 0.0in
Radius: 85'
Arc : 360°
Flow : 43.30gpm
0.50
0.25
0.00
90
Distance in Feet

Trouble!

Rotor Nozzle Selection

TROUBLE!

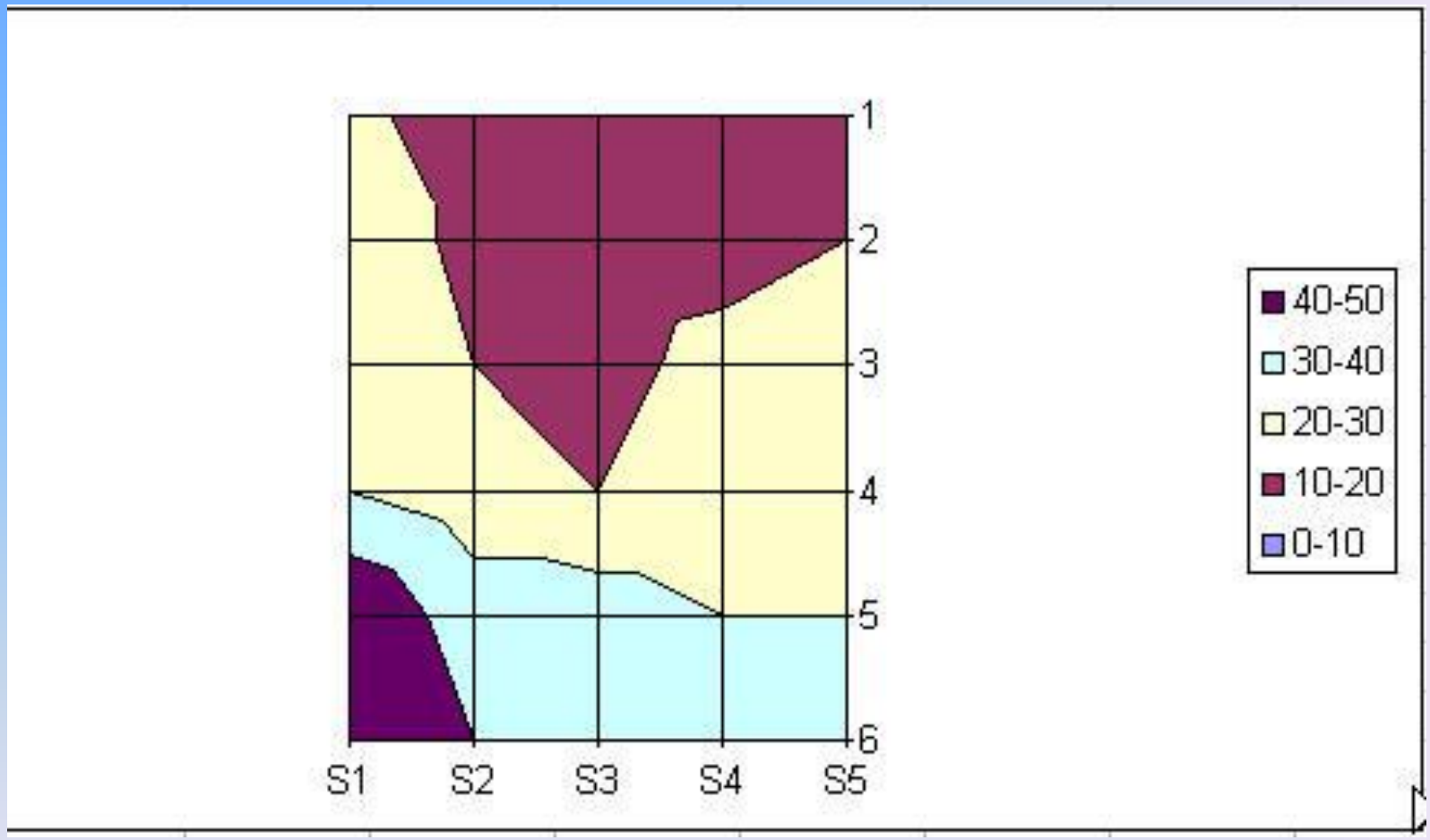



Catch Cans

Actual Audit at Derrick/Alkek data

	A	B	C	D	E	F	G	H	I	J
1	**Lawn Area Between Derrick and Alkek - Audit 11-15-05**									
2										
3	*Equally spaced approx 3' on grid, top left can 22' from post on side*						AVG			
4							DEV			
5		25	10	10	10	20	6			
6		25	18	13	15	20	3.44		30 catches	
7		20	20	16	24	25	2.8		1/4 x 30 = 7.5	
8		30	24	20	20	20	3.36		8 low catches	
9		49	35	35	30	30	5.28			
10		40	40	35	35	35	2.4		AVG CATCH IN LQ =	
11		189	147	129	134	150			14.5	
12				AVG CATCH =		30				
13				AVG DEVIATION =		3.88				
14										
15	CU =	100 x [1-(avg. dev/avg catch)]				DU(lq) =	100 x [avg catch in LQ/avg catch]			
16		100 x [1-(3.88/30)]					100 x [14.5/30]			
17		100 x [1-0.129]					100 x .483			
18		100 x .87				DU(lq) =	48%			
19	CU =	87%								
20										

Actual Audit at Derrick/Alkek graph



Go Over Scheduling Handout

- Scheduling Simplified
- For this group, should also include an adjustment factor (A_f) after ET has been determined
- PET x K_c x A_f
- Rainfall not included because handout is based on historical data and the use of rain sensors will lessen impact of rainfall on scheduling

Adjustment Factor for Quality Desired

- Maximum 1.0
- High 0.8
- Normal 0.6
- Low 0.5
- Minimum 0.4

Remember… the Goals of Effective Landscape Water Management are:

- Apply the right amount of water
- At the right rate
- At the right time
- With good uniformity

Questions?

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