Effective Rain

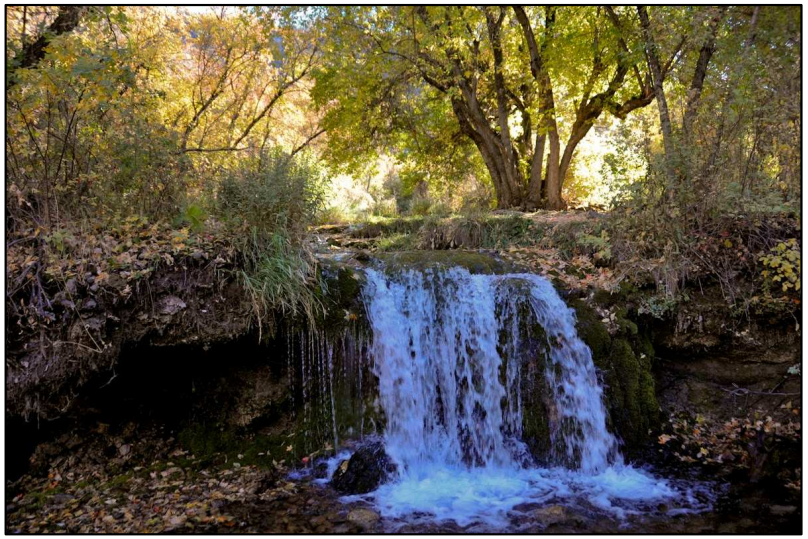
Landscape Water Management

Weather Reach®
Smart Irrigation Control

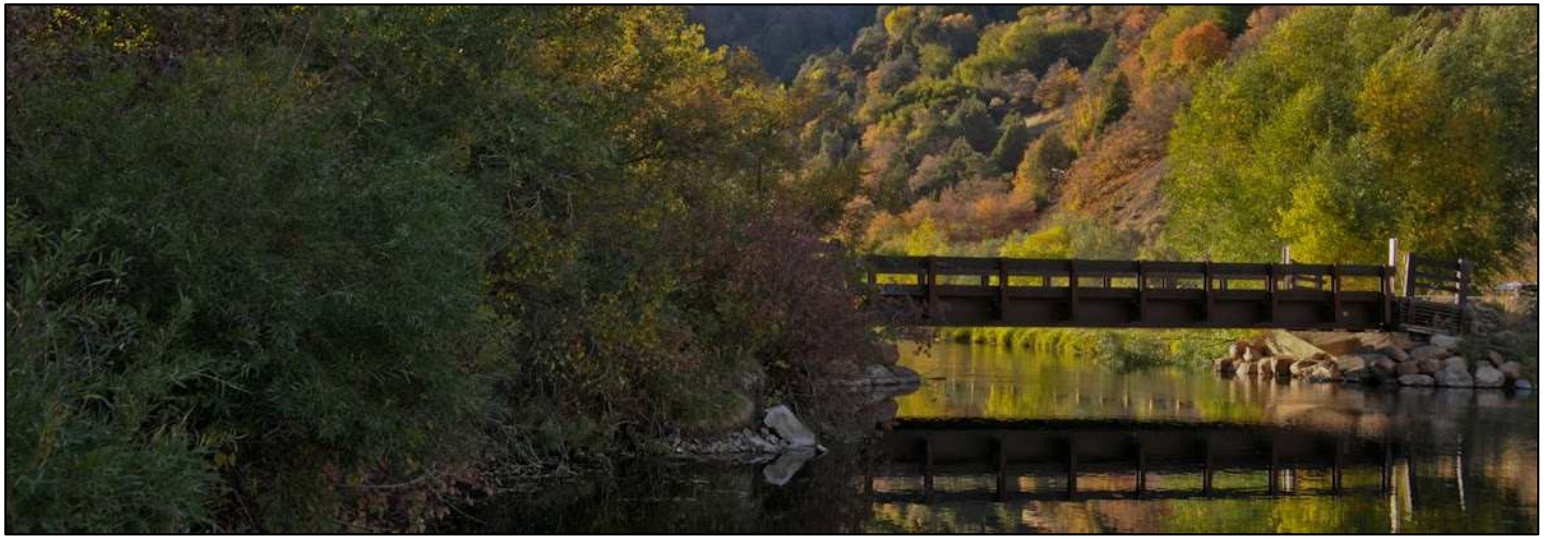
Steven Moore

Founder and President Irrisoft, Inc.
A Campbell Scientific Company

My Passions



Efficient Water Use

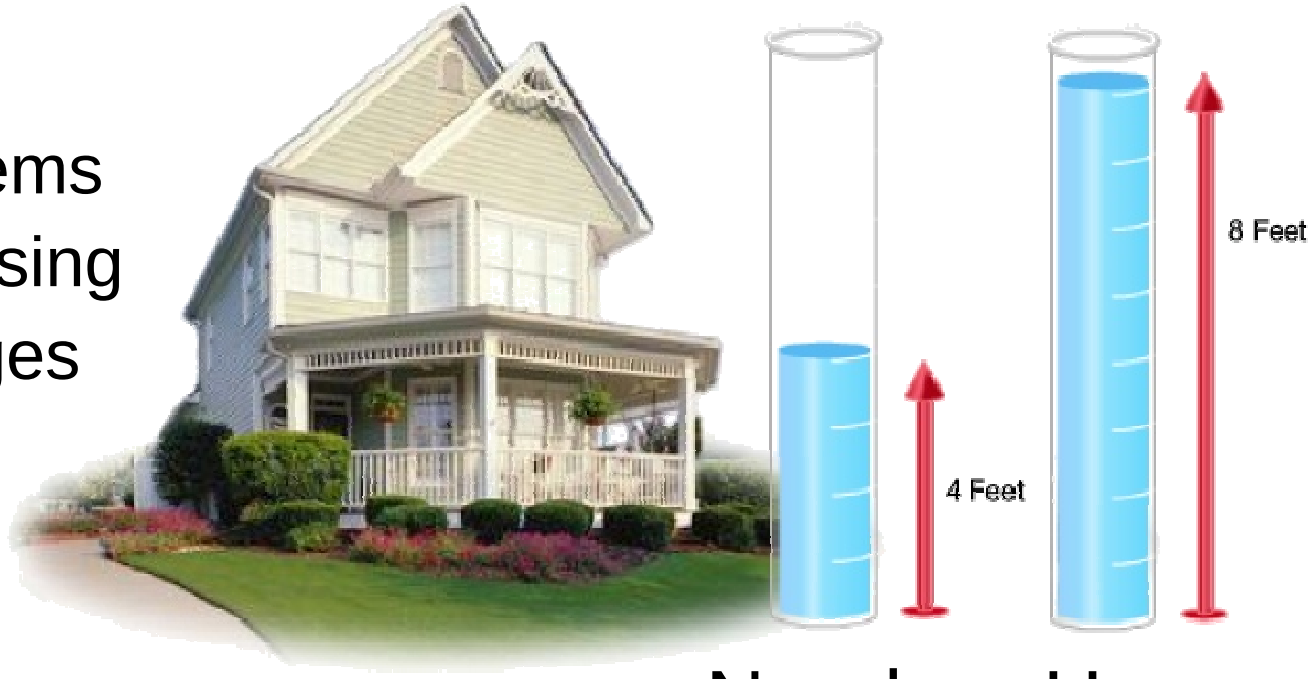


Beautiful Landscapes

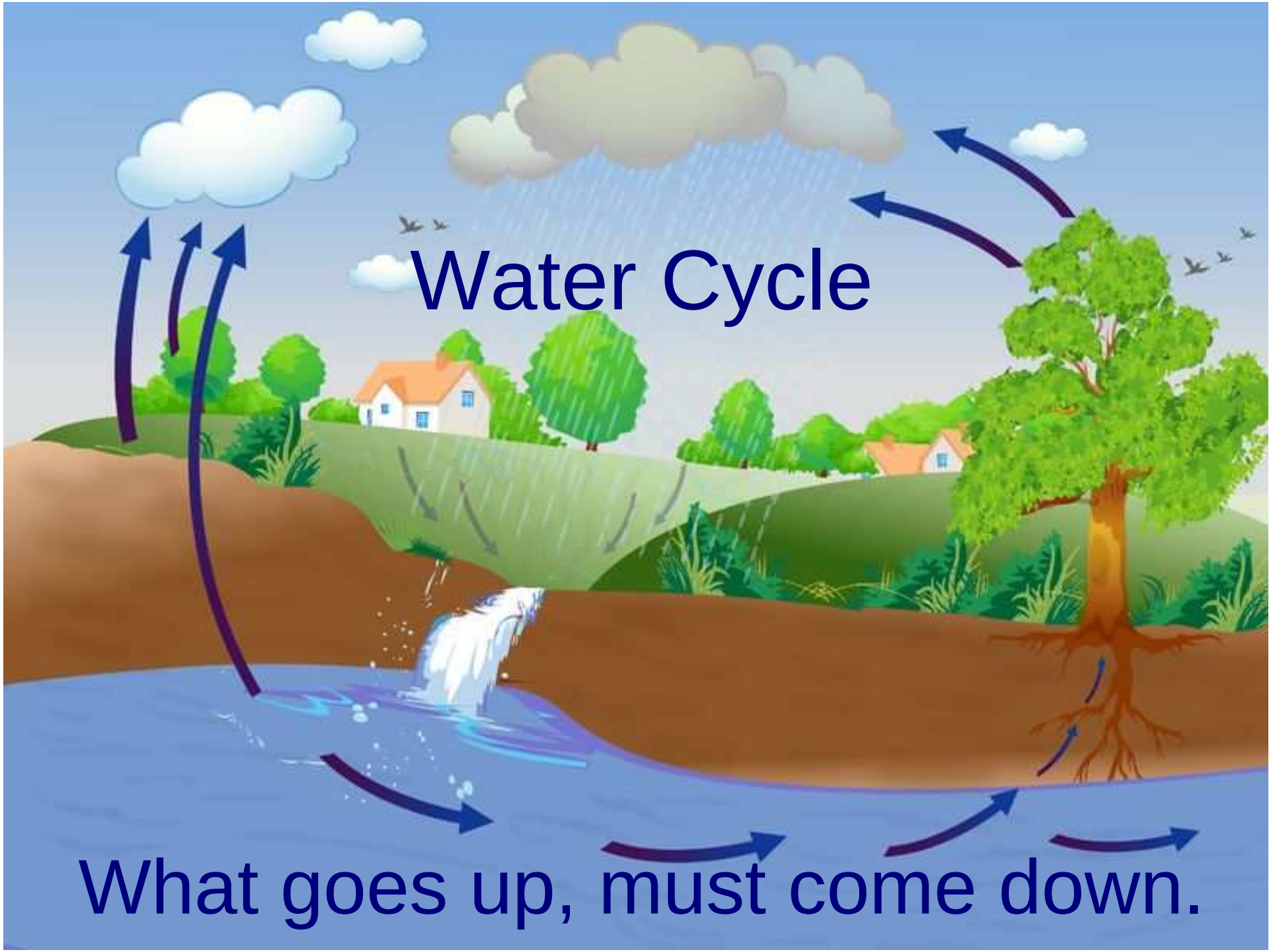
The Problem

Find the Waste

- Landscapes are Over Watered
  - 2x as much or more
- Cause?
  - Inefficient Systems
  - Schedule Guessing
  - Weather Changes
- Impact?
  - Wasting Money
  - Wasting Water



Need vs. Use


Water Cycle
What goes up, must come down.

Measure ET ● Measure Rain ● Know when to Water

ET minus Rain = Irrigation

(Evapotranspiration)

Inches

-

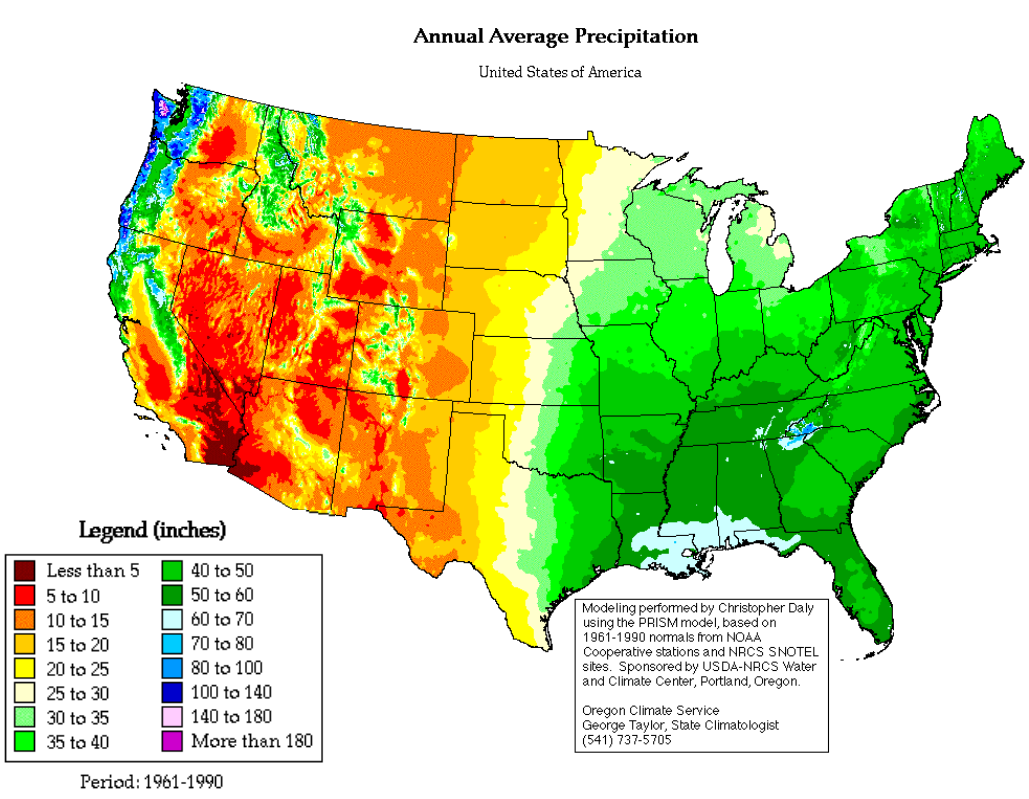
Inches

=

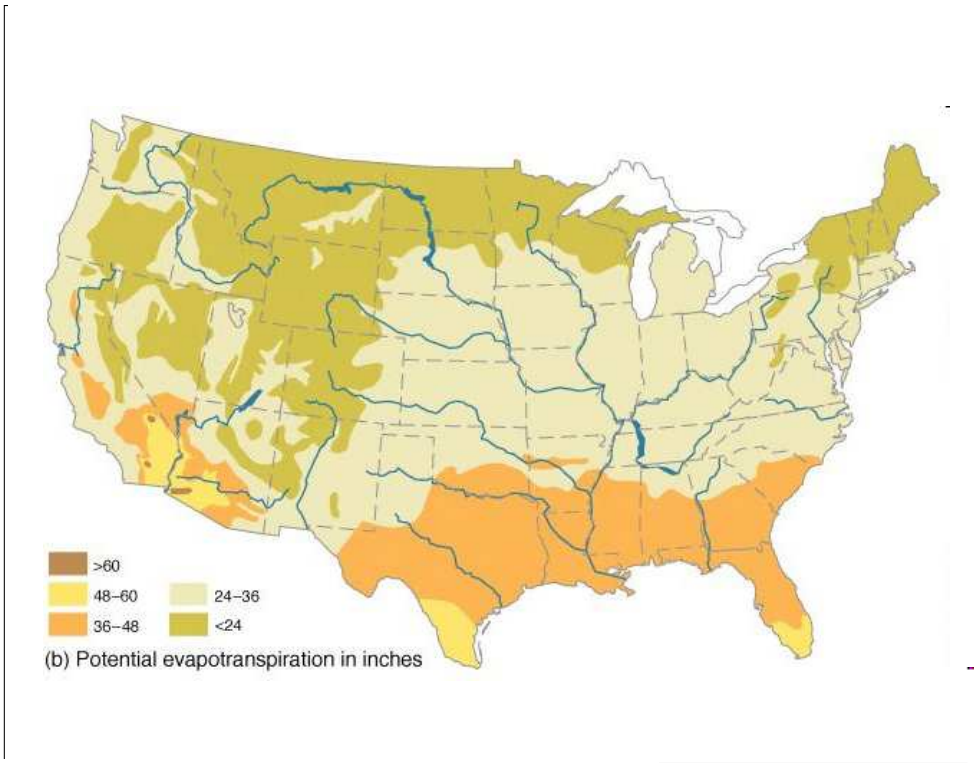
Inches

Much of the US
More Rain than ET

Rain



ET



Rain & Irrigation Control

1 Don’t water when it’s raining.

2 Know ***when*** to water after the storm.

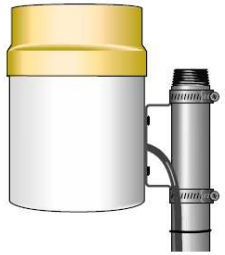
Effective Rain:

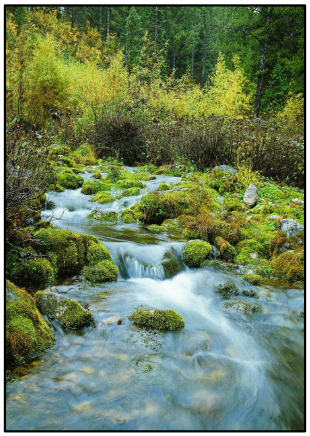
Rainfall minus surface **runoff** and percolation below the **roots**.

The Root of the Issue is Soil

Quantifying Effective Rain

#1 Measure Rainfall



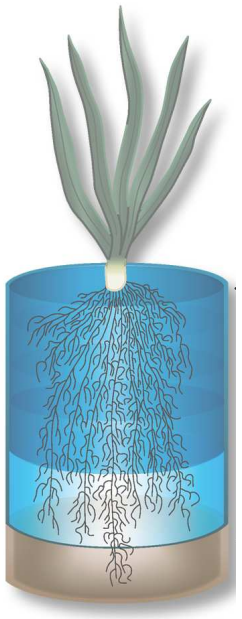


#2 Run-Off

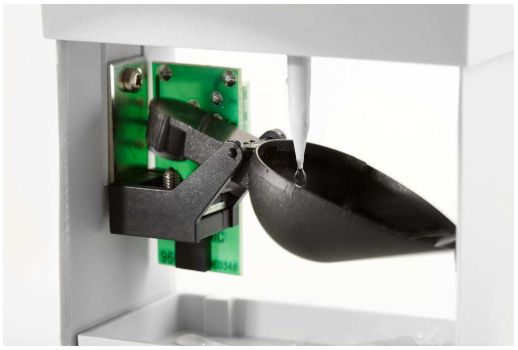
Ignore rain that falls faster than soil can absorb.

#3 Soil Moisture Content

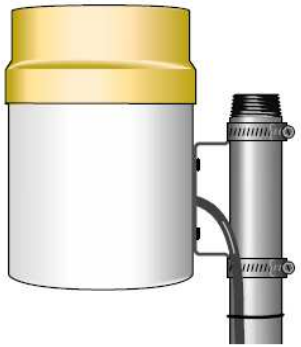
How much rain can the soil hold?

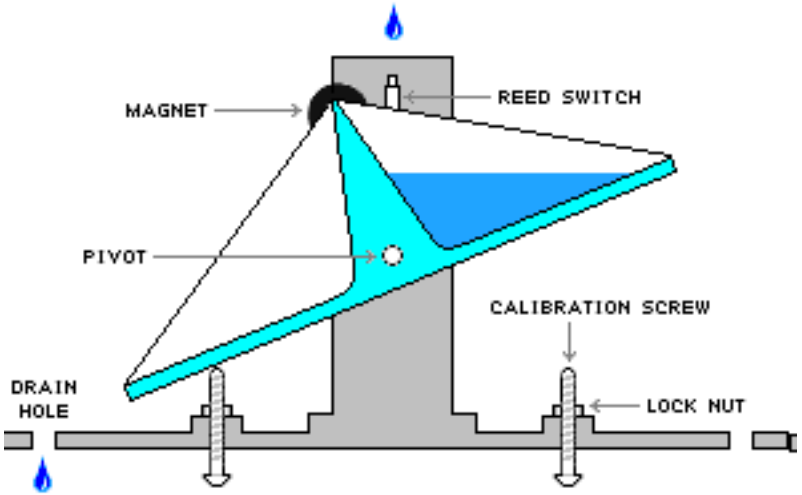


#1 Measure Rain



- Devices
  - Tipping Bucket
  - Water Weight
  - Droplet Impact





#2 Runoff

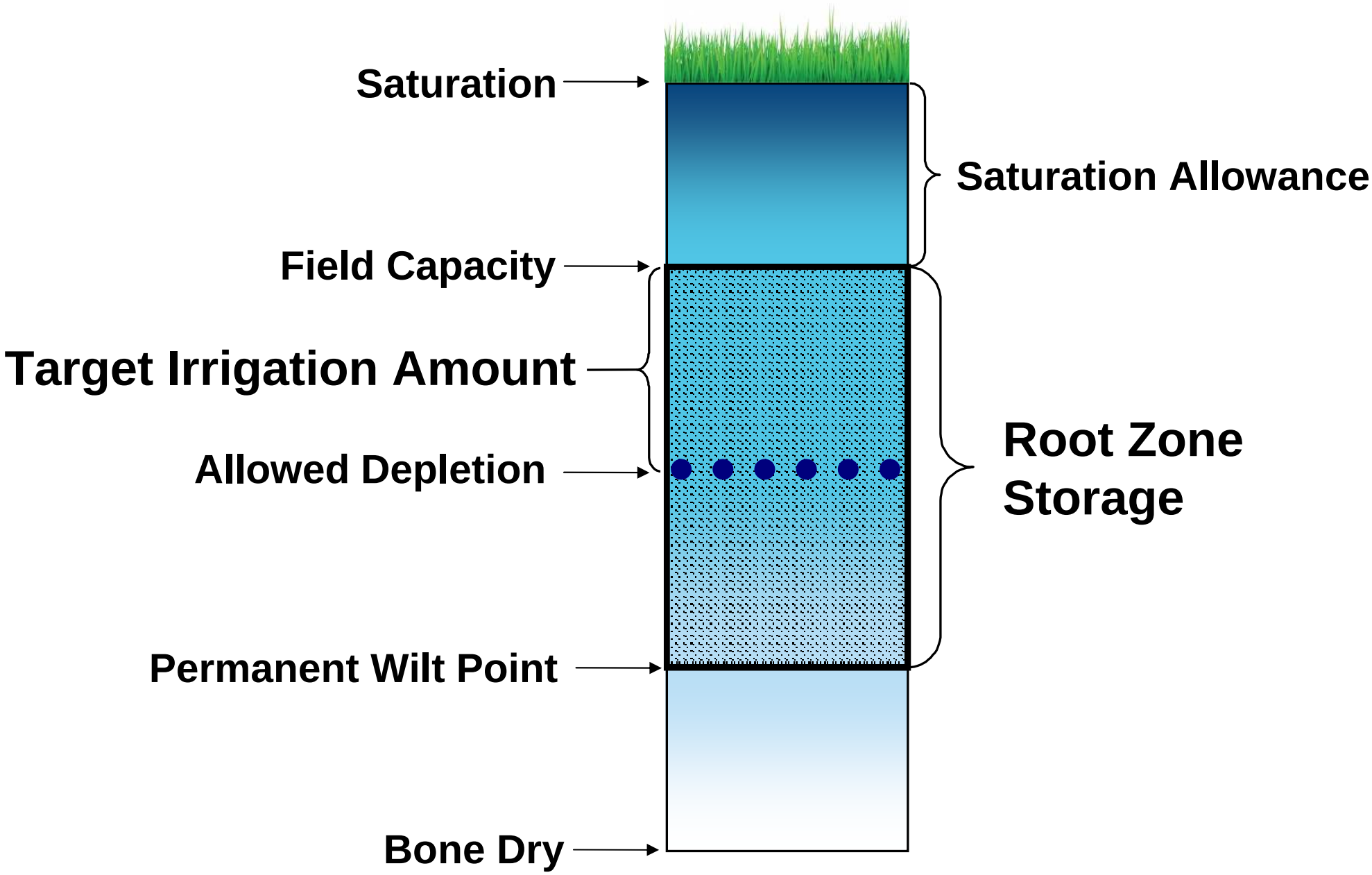
Rain that falls faster than the soil can absorb.

- Rain Fall Rate – Inches per Hour
- Soil Intake Rate – Inches per Hour

Soil Type	Average Soil Intake Rate (Inches per Hour)
Clay	0.1
Silty Clay	0.15
Clay Loam	0.2
Loam	0.35
Sandy Loam	0.4
Loamy Sand	0.5
Sand	0.6

Ignore rain that falls faster than the soil can absorb.

#3 The Soil Reservoir



Quantify Root Zone Storage Capacity

- Variables
  - Soil Type
    - Available Water (AW) – Inch per Inch
  - Root Depth (RD) - Inches
  - Managed Allowed Depletion (MAD) - %
  - Saturation Allowance (SA) - Inches

- Resulting Limits
  - Root Zone Capacity (RZC) = AW x RD
  - Allowed Depletion (AD) = RZC x MAD%
    - Optimum Irrigation Amount = AD
  - Moisture Balance Limit = AD + SA

Allowable Depletion

Soil Type	Available Water* Inch / Inch	MAD %**	Calculated Allowable Depletion					
			Root Depth in Inches					
			2	4	6	8	12	18
Sand	0.02	60%	0.02	0.05	0.07	0.10	0.14	0.22
Fine Sand	0.06	60%	0.07	0.14	0.22	0.29	0.43	0.65
Loamy Sand	0.07	60%	0.08	0.17	0.25	0.34	0.50	0.76
Sandy Loam	0.12	50%	0.12	0.24	0.36	0.48	0.72	1.08
Sandy Clay	0.16	50%	0.16	0.32	0.48	0.64	0.96	1.44
Loam	0.17	50%	0.17	0.34	0.51	0.68	1.02	1.53
Sandy Clay Loam	0.15	50%	0.15	0.30	0.45	0.60	0.90	1.35
Silty Loam	0.20	50%	0.20	0.40	0.60	0.80	1.20	1.80
Clay Loam	0.20	50%	0.20	0.40	0.60	0.80	1.20	1.80
Silt	0.17	50%	0.17	0.34	0.51	0.68	1.02	1.53
Silty Clay Loam	0.20	50%	0.20	0.40	0.60	0.80	1.20	1.80
Silty Clay	0.16	40%	0.13	0.26	0.38	0.51	0.77	1.15
Clay	0.15	30%	0.09	0.18	0.27	0.36	0.54	0.81

***** Soil Conservation Service Nation Engineering Handbook, September 1997

****** Irrigation Association Best Management Practices – Landscape Irrigation Scheduling and Water Management, September 2003

Soil is a Reservoir

Checkbook Method

ET Depletes Soil Moisture

Rain & Irrigation Replenish Soil Moisture

Seattle Center

Crop Coefficient (Kc)=0.80

	Jun 9	Jun 10	Jun 11	Jun 12	Jun 13	Jun 14	Jun 15	Jun 16	Jun 17	Jun 18	Jun 19	Jun 20	Jun 21	Jun 22
Evaporation	0.09	0.13	0.09	0.13	0.10	0.09	0.13	0.11	0.13	0.15	0.07	0.04	0.09	0.15
Rain			0.02									0.33	0.06	
Irrigation			0.50					0.50						
Moisture Level	0.16	0.03	0.46	0.33	0.23	0.14	0.01	0.40	0.27	0.12	0.05	0.34	0.30	0.15

Heavy Storm

Castle Pines

Crop Coefficient (Kc)=0.80

	Sep 8	Sep 9	Sep 10	Sep 11	Sep 12	Sep 13	Sep 14	Sep 15	Sep 16	Sep 17	Sep 18	Sep 19	Sep 20	Sep 21
Evaporation	0.13	0.11	0.04	0.03	0.04	0.07	0.07	0.03	0.09	0.12	0.11	0.07	0.10	0.11
Rain			0.78	0.53	1.45	0.51	0.32	0.26	0.01					
Irrigation														
Moisture Level	0.12	0.02	0.75	0.75	0.75	0.68	0.75	0.75	0.66	0.55	0.44	0.37	0.28	0.16

Light Sustained Drizzle

Everett Washington

Crop Coefficient (Kc)=0.80

	Apr 9	Apr 10	Apr 11	Apr 12	Apr 13	Apr 14	Apr 15	Apr 16	Apr 17	Apr 18	Apr 19	Apr 20	Apr 21	Apr 22
Evaporation	0.05	0.05	0.06	0.02	0.03	0.06	0.07	0.07	0.08	0.02	0.02	0.03	0.05	0.10
Rain	0.01	0.05	0.09	0.17	0.08	0.06	0.07	0.01		0.12	0.30	0.18	0.19	
Irrigation														
Moisture Level	0.21	0.21	0.25	0.39	0.44	0.44	0.44	0.37	0.29	0.39	0.66	0.75	0.71	0.61

Summer Thunder Storm

Castle Pines

Crop Coefficient (Kc)=0.80

	Jul 8	Jul 9	Jul 10	Jul 11	Jul 12	Jul 13	Jul 14	Jul 15	Jul 16	Jul 17	Jul 18	Jul 19	Jul 20	Jul 21
Evaporation	0.19	0.15	0.15	0.18	0.15	0.13	0.12	0.09	0.16	0.17	0.18	0.13	0.16	0.16
Rain						0.07	1.12	0.06						
Irrigation		0.50			0.50								0.50	
Moisture Level	0.06	0.41	0.26	0.08	0.43	0.38	0.75	0.66	0.50	0.33	0.14	0.01	0.35	0.19

Example 1

99% Rainfall Efficiency

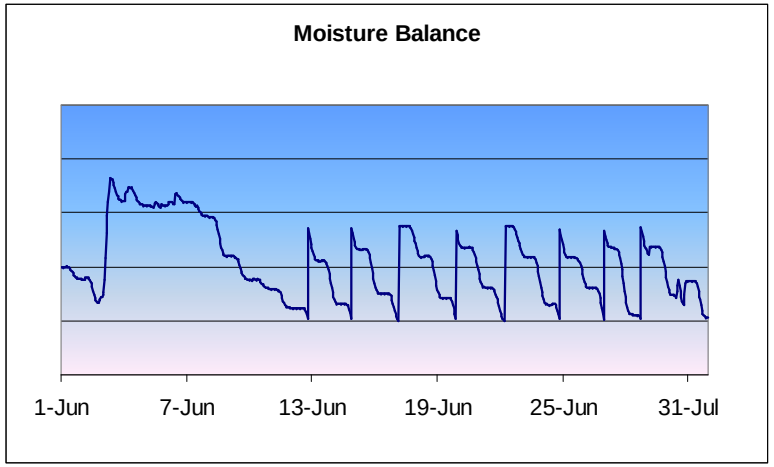
Aurora, CO

Variables

Soil Type	Sandy Clay Loam
Available Water in/in	0.11
Root Depth - Inches	8.00
Managed Allowed Depletion	50%
Saturation Allowance	0.22
Maximum Hourly Rain	0.35

Resulting Limits

Root Zone Capactity	0.88
Allowed Depletion	0.44
Optimum Irrigation Amount	0.44
Moisture Balance Limit	0.66



Moisture Balance

Date	ET	Total Rain	Effective Rain	Irrigation	Moisture Balance
6/1/2008	0.06	0.00	0.00	0.00	0.19
6/2/2008	0.12	0.04	0.04	0.00	0.11
6/3/2008	0.12	0.58	0.57	0.00	0.56
6/4/2008	0.09	0.07	0.07	0.00	0.54
6/5/2008	0.06	0.06	0.06	0.00	0.53
6/6/2008	0.07	0.08	0.08	0.00	0.55
6/7/2008	0.07	0.01	0.01	0.00	0.48
6/8/2008	0.19	0.00	0.00	0.00	0.30
6/9/2008	0.11	0.00	0.00	0.00	0.19
6/10/2008	0.06	0.02	0.02	0.00	0.15
6/11/2008	0.10	0.01	0.01	0.00	0.06
6/12/2008	0.14	0.00	0.00	0.44	0.36
6/13/2008	0.21	0.00	0.00	0.00	0.15
6/14/2008	0.19	0.00	0.00	0.44	0.40
6/15/2008	0.21	0.00	0.00	0.00	0.20
6/16/2008	0.15	0.00	0.00	0.00	0.05
6/17/2008	0.13	0.00	0.00	0.44	0.36
6/18/2008	0.20	0.00	0.00	0.00	0.16
6/19/2008	0.21	0.00	0.00	0.44	0.40
6/20/2008	0.16	0.00	0.00	0.00	0.24
6/21/2008	0.17	0.00	0.00	0.00	0.07
6/22/2008	0.16	0.00	0.00	0.44	0.35
6/23/2008	0.19	0.00	0.00	0.00	0.16
6/24/2008	0.22	0.00	0.00	0.44	0.37
6/25/2008	0.16	0.00	0.00	0.00	0.22
6/26/2008	0.21	0.00	0.00	0.00	0.00
6/27/2008	0.30	0.00	0.00	0.44	0.14
6/28/2008	0.24	0.00	0.00	0.44	0.34
6/29/2008	0.18	0.04	0.04	0.00	0.20
6/30/2008	0.28	0.26	0.26	0.00	0.18
Total	4.74	1.17	1.16	3.52	
			99%		8 Water Days

Example 2

36% Rainfall Efficiency

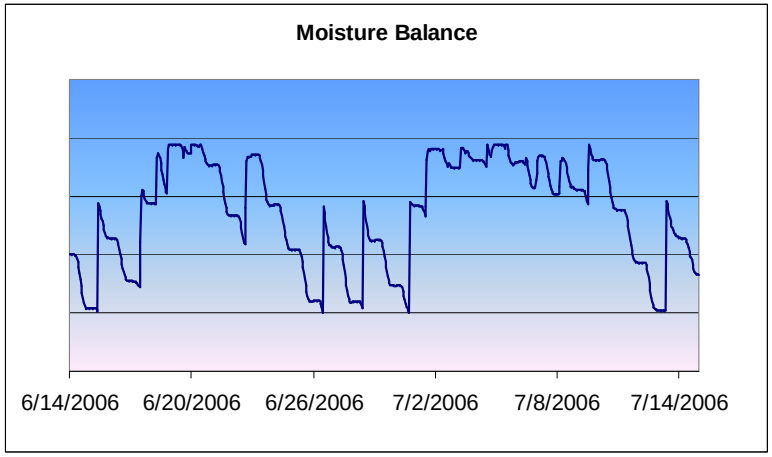
Houston, TX

Variables

Soil Type	Clay Loam
Available Water in/in	0.16
Root Depth - Inches	6.00
Managed Allowed Depletion	50%
Saturation Allowance	0.24
Maximum Hourly Rain	0.20

Resulting Limits

Root Zone Capactity	0.96
Allowed Depletion	0.48
Optimum Irrigation Amount	0.48
Moisture Balance Limit	0.72



Moisture Balance

Date	ET	Total Rain	Effective Rain	Irrigation	Moisture Balance
6/14/2006	0.23	0.00	0.00	0.00	0.02
6/15/2006	0.18	0.00	0.00	0.48	0.32
6/16/2006	0.18	0.00	0.00	0.00	0.14
6/17/2006	0.09	1.13	0.42	0.00	0.47
6/18/2006	0.18	0.48	0.43	0.00	0.72
6/19/2006	0.10	0.94	0.06	0.00	0.68
6/20/2006	0.11	0.40	0.06	0.00	0.63
6/21/2006	0.22	0.00	0.00	0.00	0.42
6/22/2006	0.14	0.60	0.40	0.00	0.68
6/23/2006	0.22	0.00	0.00	0.00	0.46
6/24/2006	0.19	0.00	0.00	0.00	0.27
6/25/2006	0.22	0.00	0.00	0.00	0.05
6/26/2006	0.25	0.00	0.00	0.48	0.28
6/27/2006	0.24	0.00	0.00	0.00	0.05
6/28/2006	0.22	0.00	0.00	0.48	0.31
6/29/2006	0.19	0.00	0.00	0.00	0.12
6/30/2006	0.14	0.00	0.00	0.48	0.46
7/1/2006	0.07	0.55	0.31	0.00	0.70
7/2/2006	0.11	0.03	0.03	0.00	0.62
7/3/2006	0.08	0.11	0.11	0.00	0.65
7/4/2006	0.09	0.59	0.16	0.00	0.72
7/5/2006	0.11	1.34	0.04	0.00	0.65
7/6/2006	0.15	0.07	0.07	0.00	0.57
7/7/2006	0.16	0.10	0.10	0.00	0.51
7/8/2006	0.14	0.16	0.16	0.00	0.53
7/9/2006	0.14	0.68	0.26	0.00	0.66
7/10/2006	0.21	0.00	0.00	0.00	0.44
7/11/2006	0.23	0.00	0.00	0.00	0.22
7/12/2006	0.20	0.00	0.00	0.00	0.01
7/13/2006	0.17	0.00	0.00	0.48	0.32
7/14/2006	0.16	0.00	0.00	0.00	0.16
Total	5.09	7.18	2.61	2.40	
			36%		5 Water Days

Example 3

45% Rainfall Efficiency

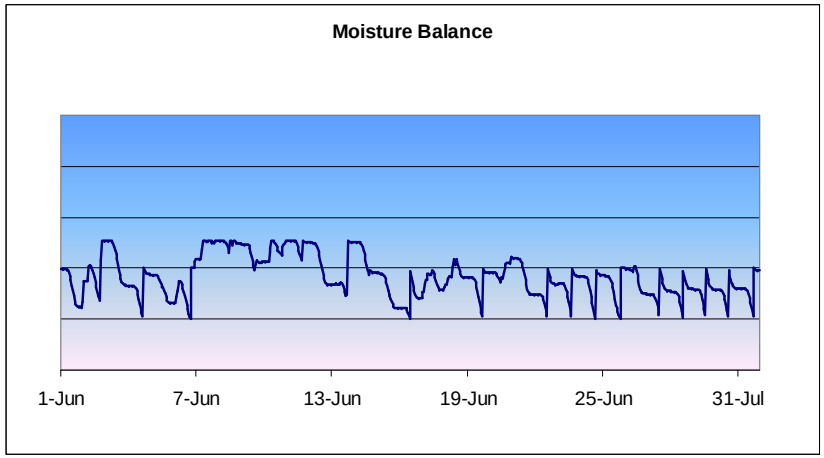
Logan, UT

Variables

Soil Type	Silty Clay Loam
Available Water in/in	0.17
Root Depth - Inches	3.00
Managed Allowed Depletion	50%
Saturation Allowance	0.13
Maximum Hourly Rain	0.35

Resulting Limits

Root Zone Capactity	0.51
Allowed Depletion	0.26
Optimum Irrigation Amount	0.26
Moisture Balance Limit	0.38



Moisture Balance

Date	ET	Total Rain	Effective Rain	Irrigation	Moisture Balance
6/1/2009	0.19	0.03	0.03	0.00	0.09
6/2/2009	0.18	1.37	0.47	0.00	0.38
6/3/2009	0.22	0.00	0.00	0.00	0.16
6/4/2009	0.20	0.00	0.00	0.26	0.22
6/5/2009	0.15	0.01	0.01	0.00	0.08
6/6/2009	0.19	0.14	0.14	0.26	0.28
6/7/2009	0.06	0.97	0.16	0.00	0.38
6/8/2009	0.13	0.55	0.12	0.00	0.37
6/9/2009	0.15	0.06	0.06	0.00	0.28
6/10/2009	0.08	0.38	0.18	0.00	0.38
6/11/2009	0.11	0.39	0.11	0.00	0.38
6/12/2009	0.21	0.00	0.00	0.00	0.17
6/13/2009	0.09	0.33	0.30	0.00	0.38
6/14/2009	0.18	0.03	0.03	0.00	0.23
6/15/2009	0.17	0.00	0.00	0.00	0.06
6/16/2009	0.21	0.00	0.00	0.26	0.10
6/17/2009	0.13	0.17	0.17	0.00	0.15
6/18/2009	0.14	0.20	0.20	0.00	0.20
6/19/2009	0.23	0.00	0.00	0.26	0.23
6/20/2009	0.07	0.15	0.15	0.00	0.30
6/21/2009	0.18	0.00	0.00	0.00	0.12
6/22/2009	0.20	0.00	0.00	0.26	0.17
6/23/2009	0.22	0.00	0.00	0.26	0.21
6/24/2009	0.25	0.00	0.00	0.26	0.21
6/25/2009	0.22	0.00	0.00	0.26	0.25
6/26/2009	0.17	0.04	0.04	0.00	0.12
6/27/2009	0.24	0.00	0.00	0.26	0.14
6/28/2009	0.24	0.00	0.00	0.26	0.15
6/29/2009	0.26	0.00	0.00	0.26	0.14
6/30/2009	0.25	0.00	0.00	0.26	0.15
7/31/2009	0.17	0.00	0.00	0.26	0.24
Total	5.49	4.82	2.17	3.32	
			45%		13 Water Days

Example 4

63% Rainfall Efficiency

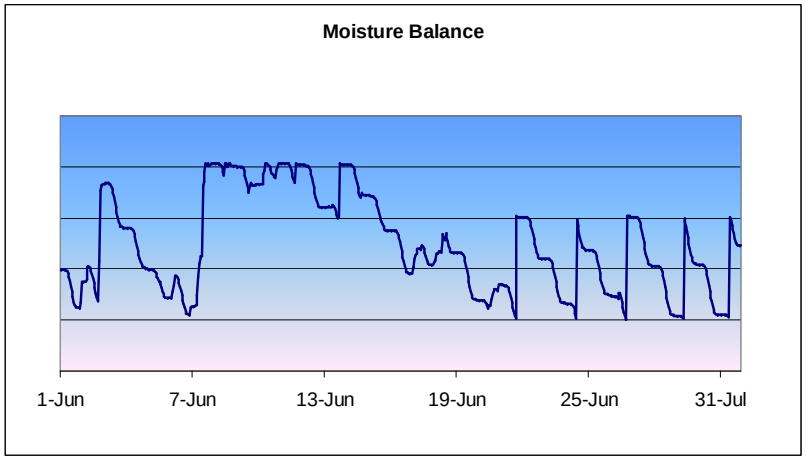
Logan, UT

Variables

Soil Type	Silty Clay Loam
Available Water in/in	0.17
Root Depth - Inches	6.00
Managed Allowed Depletion	50%
Saturation Allowance	0.26
Maximum Hourly Rain	0.35

Resulting Limits

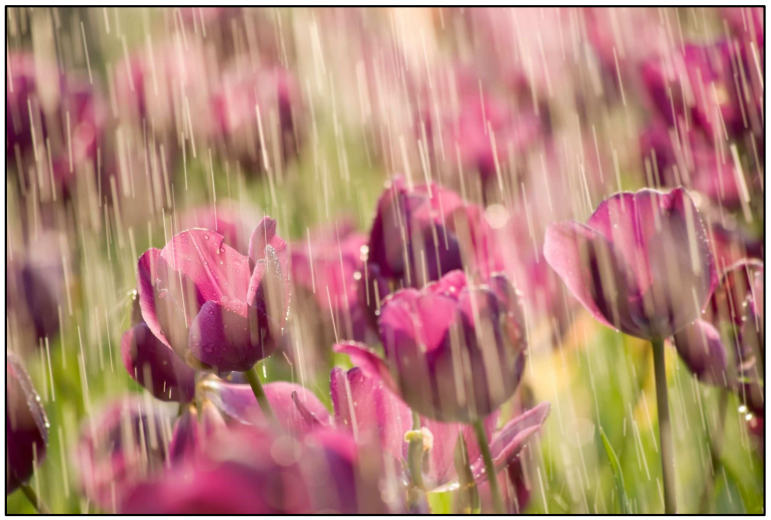
Root Zone Capactity	1.02
Allowed Depletion	0.51
Optimum Irrigation Amount	0.51
Moisture Balance Limit	0.77



Moisture Balance

Date	ET	Total Rain	Effective Rain	Irrigation	Moisture Balance
6/1/2009	0.19	0.03	0.03	0.00	0.09
6/2/2009	0.18	1.37	0.76	0.00	0.67
6/3/2009	0.22	0.00	0.00	0.00	0.45
6/4/2009	0.20	0.00	0.00	0.00	0.25
6/5/2009	0.15	0.01	0.01	0.00	0.11
6/6/2009	0.19	0.14	0.14	0.00	0.06
6/7/2009	0.06	0.97	0.77	0.00	0.77
6/8/2009	0.13	0.55	0.12	0.00	0.75
6/9/2009	0.15	0.06	0.06	0.00	0.67
6/10/2009	0.08	0.38	0.18	0.00	0.77
6/11/2009	0.11	0.39	0.11	0.00	0.76
6/12/2009	0.21	0.00	0.00	0.00	0.55
6/13/2009	0.09	0.33	0.30	0.00	0.76
6/14/2009	0.18	0.03	0.03	0.00	0.61
6/15/2009	0.17	0.00	0.00	0.00	0.44
6/16/2009	0.21	0.00	0.00	0.00	0.23
6/17/2009	0.13	0.17	0.17	0.00	0.27
6/18/2009	0.14	0.20	0.20	0.00	0.33
6/19/2009	0.23	0.00	0.00	0.00	0.10
6/20/2009	0.07	0.15	0.15	0.00	0.18
6/21/2009	0.18	0.00	0.00	0.51	0.50
6/22/2009	0.20	0.00	0.00	0.00	0.30
6/23/2009	0.22	0.00	0.00	0.00	0.08
6/24/2009	0.25	0.00	0.00	0.51	0.34
6/25/2009	0.22	0.00	0.00	0.00	0.12
6/26/2009	0.17	0.04	0.04	0.51	0.51
6/27/2009	0.24	0.00	0.00	0.00	0.26
6/28/2009	0.24	0.00	0.00	0.00	0.02
6/29/2009	0.26	0.00	0.00	0.51	0.27
6/30/2009	0.25	0.00	0.00	0.00	0.02
7/31/2009	0.17	0.00	0.00	0.51	0.37
Total	5.49	4.82	3.06	2.55	
			63%		5 Water Days

Increasing Effective Rain

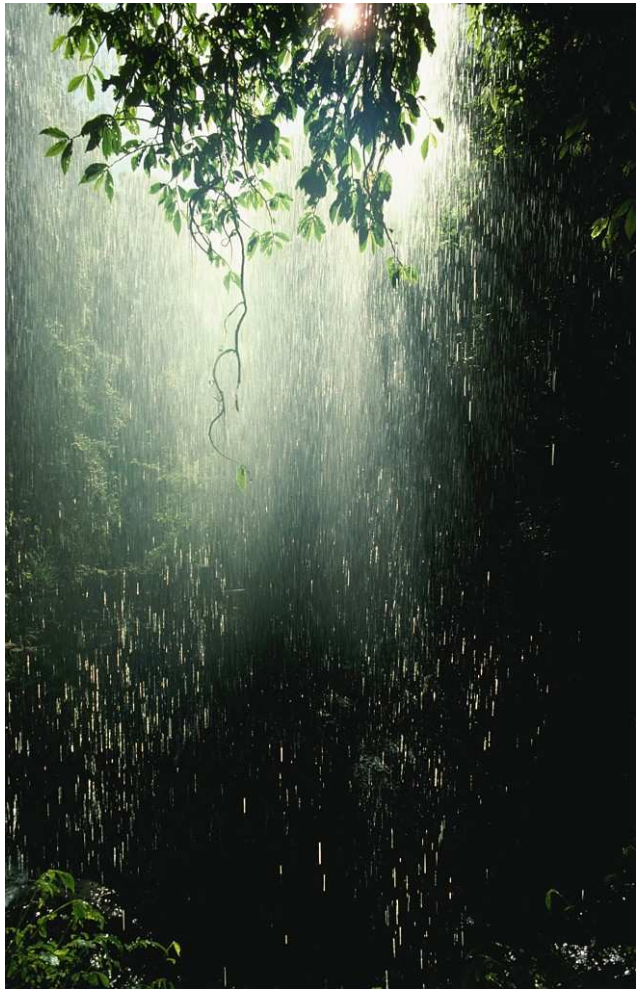


- Increase Soil Reservoir Capacity
  - Increase root depth
    - Water management
    - Soil preparation
- Monitor Current Moisture Content
  - Anticipate potential rain and delay watering
- Improve Permeability - Maximum Hourly Rate
  - Mulch
  - Cultivation
  - Soil Amendments

Measurements Improve Control

"You can't control what you can't measure"

Tom DeMarco – Water Smart Innovations Conference Las Vegas 2009



Conclusions

- Measuring Effective Rain is as important as measuring ET.
- Hourly Moisture Balance modeling quantifies Effective Rain.
- Rainfall Efficiency is not a simple % of total rain.
- With proper management rainfall effectiveness can be improved.
- Measuring Effective Rain improves irrigation control efficiency.
  - Save Money
  - Reduce Wasteful Overwatering
  - Improves Landscape Health

Smart? Control

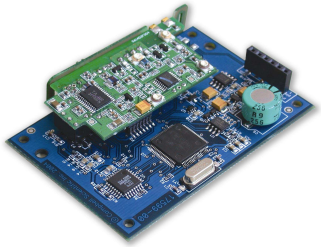
- Big on ET
- What about Rain?
  - Is a Rain Shut-off device good enough?

Measure ET and Measure Rain

ET – Rain = Irrigation

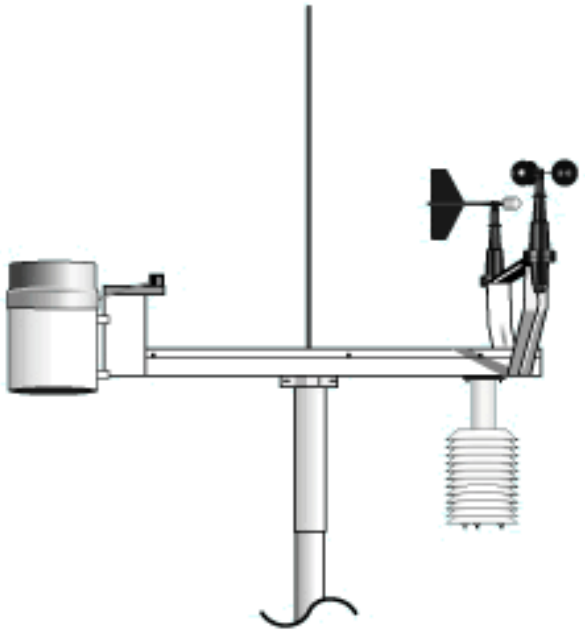
Weather Reach Product Family

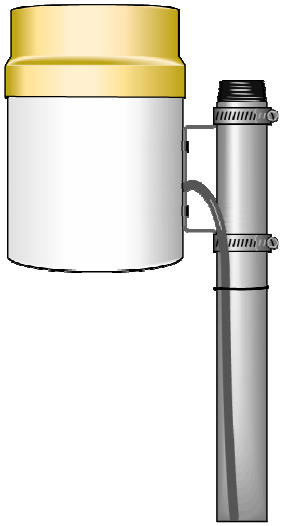
- Weather Reach
  - Controller Link
  - WR-7
  - WR-1
- Rain Bird
  - ET Manager
  - ET Manager Cartridge



Weather Reach Rain Source

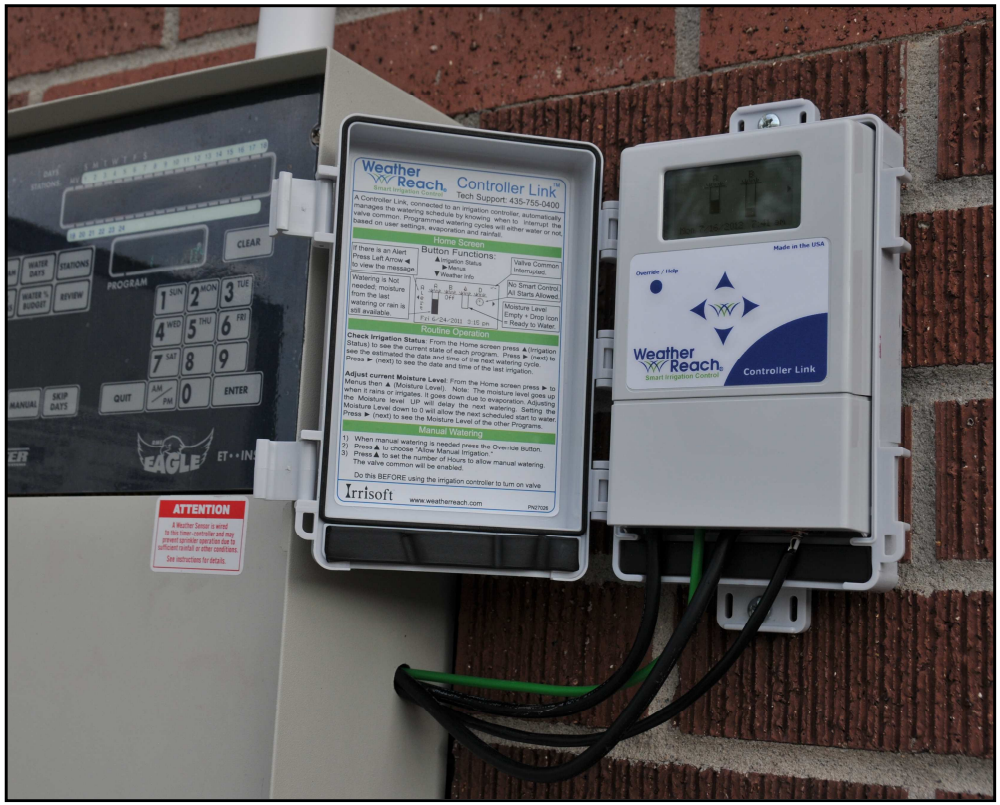
- Local Weather Station
- On-Site Tipping Rain Gauge
- Project Rain Station





Smarter Irrigation Control Measures Rain

Connect Controller Link to an Existing Sprinkler Controller



Wi-Fi enabled to retrieve weather data via the Internet.

Free!

Controls Watering

Simple & Effective

Smart Control is a Business Opportunity

Water Management

- Landscapes are overwatered.
  - Let ET Control Watering Schedules
- Improve system & scheduling efficiency.
- Climate controlled irrigation
  - Reduce wasteful overwatering.

Save Money - Save Time - Save Water - Make Money

Effective Rain Resources

- Weather Reach
  - www.weatherreach.com
- MAD Simulation
  - http://www.weatherreach.com/mad/
- Today's Webinar – send you an email
  - PDF
  - Recorded version

- Quantifying Effective Rain in Landscape Irrigation Water Management – IA Technical Conference 2009
  - http://www.weatherreach.com/images/pdf/102213ER.pdf

Future Webinars

- Irrigation System Capabilities
- Plant, Water, Soil, Relationships
- Managed Allowed Depletion
- Base Irrigation Schedule
- Smart Irrigation Control Products
- Flow Sensors
- System Fine Tuning
- Return on Investment
- Selling Water Management

Next Webinar:
November 19th

"Irrigation System Capabilities"

Effective Rain

Landscape Water Management

Weather Reach®
Smart Irrigation Control