Landscape Water Budgeting and Irrigation Efficiency

Gardenworks Inc.
QUALITY LANDSCAPE DESIGN, CONSTRUCTION & MAINTENANCE

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UTILITIES DEPARTMENT
CITY OF HEALDSBURG
CALIFORNIA SINCE 1867

SMART LIVING

Some Material Courtesy of QWEL and CLCA

Water Budget Overview

- ***What is a Water Budget***
- ***Understand Evapotranspiration (ET)***
- ***Develop a Water Budget***

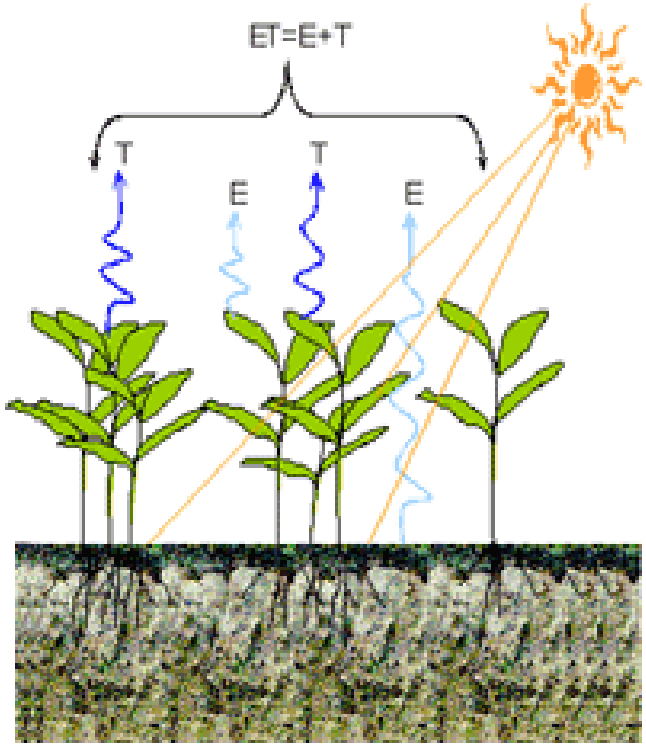
What is a Water Budget?

- **A Landscape Water Budget is an *Estimate* of How Much Water is Needed to Maintain a Healthy Landscape**

<u>Based on:</u>

- ✓ **Climate**
- ✓ **Landscape Area**
- ✓ **Plant Type**

Water Budget Calculation



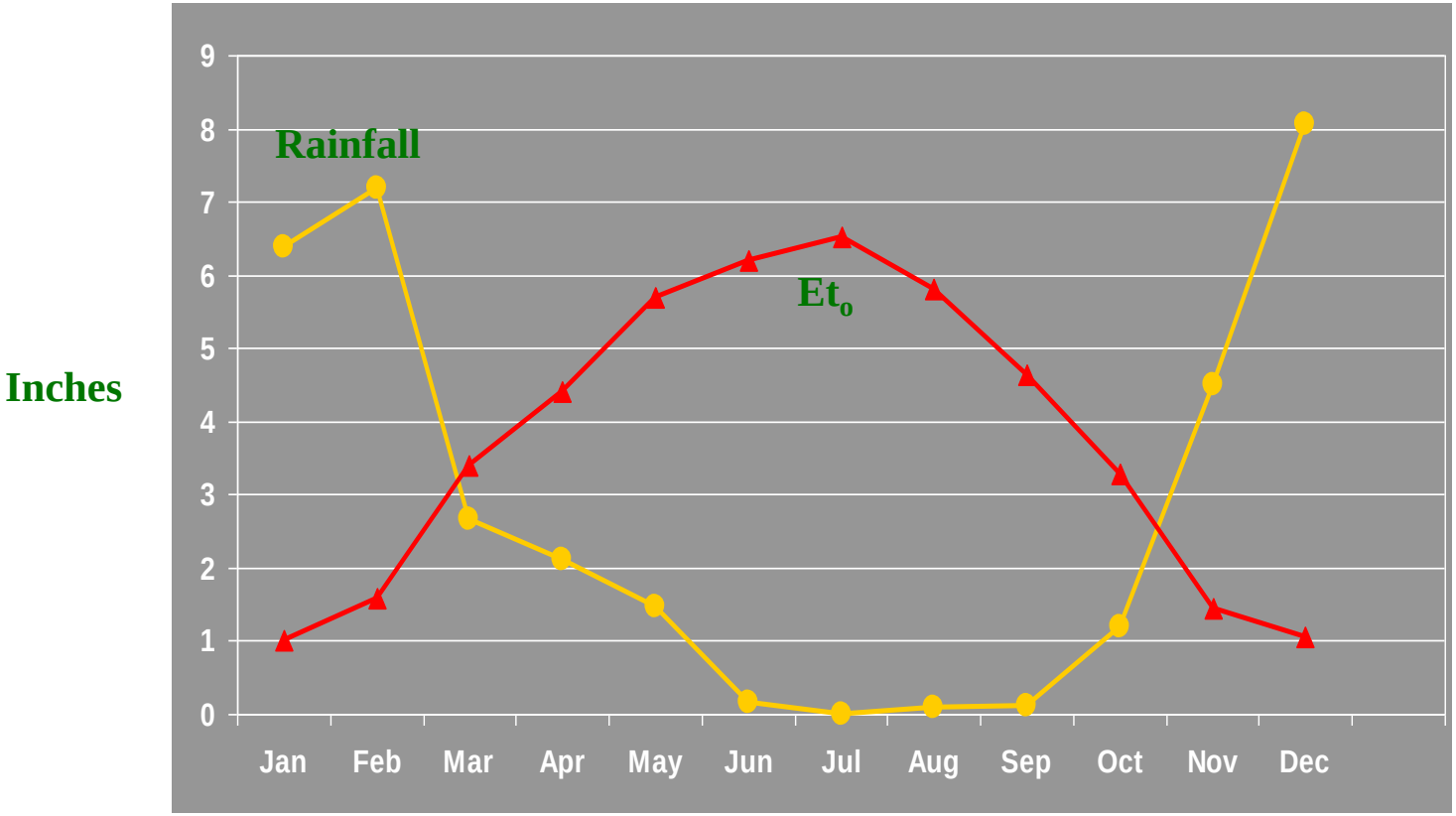
- **ET x K_L x Landscape Area = Water Budget**

ET – water loss due to weather factors which cause

- **Evaporation from soil and plant surfaces**
- **Transpiration by plants**
- ***ET changes as the weather changes***
- ***ET is calculated based on sensor information***

K_L – Plant Factor

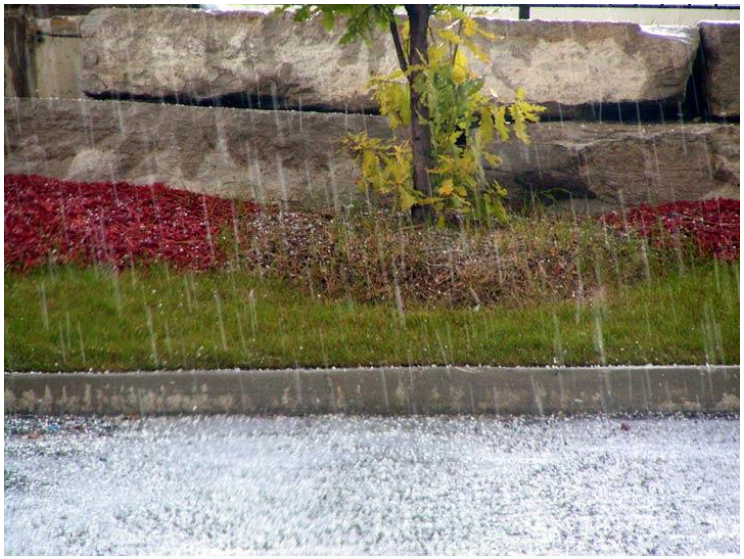
Et_o and Rainfall: A Comparison



Typical Mediterranean Area Weather Pattern

Determining Water Budgets

Water Budget and Climate



Measured in inches

- ET
- Rain
- Sprinkler Precipitation Rate

- **Convert ET to feet when performing water budget calculations (i.e. ET = 4 inches or .33 feet)**

Determining Water Budgets

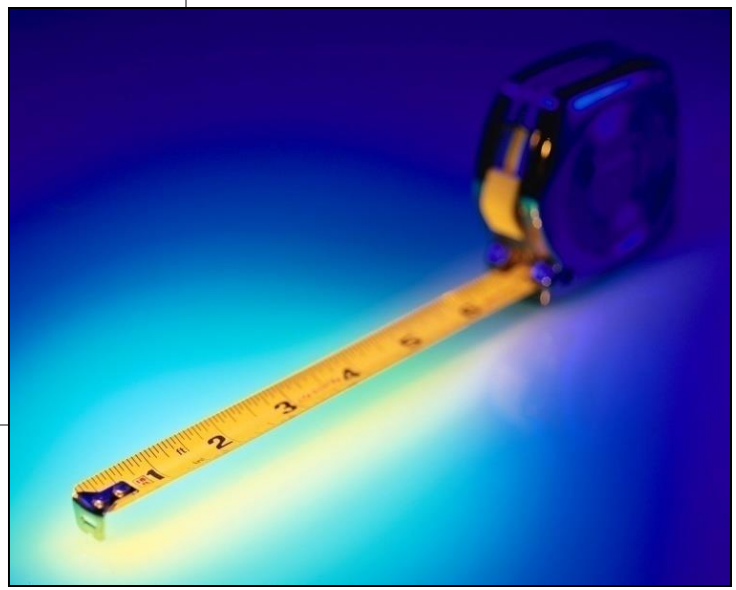
Measure Landscape Area

Measure and Multiply:

- Rectangular/Square Areas = width x height
- Circular Areas = 3.14 x radius^2
- Triangular Areas = ½ base x height

Ways to Measure

- Pace (walking)
- Measuring Wheel
- Tape Measure



Determining Water Budgets

Monthly and Average Et_o Report

Sample Weather Station Data

Net ETo per Month (Santa Rosa, CA)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
0.82	1.44	2.87	4.31	5.26	6.14	6.30	5.76	4.25	3.10	1.38	0.86	42.49

Determining Water Budgets

Water Budget Form (turf example)

Time Frames	ET_o (inches)	÷12	ET (feet)	X	K_L	X	Irrigated Area (ft^2)	=	Water budget in cubic feet	Water budget in gallons (cf x 7.48)
Week:	2	÷12	.167	x	.8	x	2500	=	334 cf	2,498 gallons
Month:	6	÷12	.5	x	.8	x	2500	=	1,000 cf	7,480 gallons
Year:	42	÷12	3.5	x	.8	x	2500	=	7,000 cf	52,360 gallons

K_L for a maintained cool season grass has an average K_L = .8

Determining Water Budgets

Water Budget Form (low water use example)

Time Frames	ET_o (inches)	÷12	ET (feet)	x	K_L	x	Irrigated Area (ft^2)	=	Water budget in cubic feet	Water budget in gallons (cf x 7.48)
Week:	2	÷12	.167	x	.3	x	2500	=	125 cf	937 gallons
Month:	6	÷12	.5	x	.3	x	2500	=	375 cf	2,805 gallons
Year:	42	÷12	3.5	x	.3	x	2500	=	2,625 cf	19,635 gallons

K_L for a low water use plant: $K_L = .3$

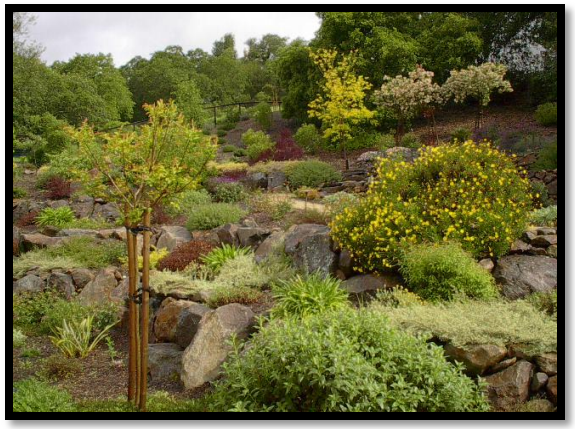
Irrigation Efficiency

Overview

1. Determine precipitation rates & use charts
2. Perform & interpret a catch can test
3. Understand matched precipitation rates & distribution uniformity
4. Be familiar with the irrigation run-time multiplier

Irrigation Efficiency

Keys To Irrigation Efficiency



Know how much water to apply
(based on weather and plants)

- Good distribution uniformity
- Matched precipitation rates
- Maintained and managed by knowledgeable staff

Irrigation Efficiency

Distribution Uniformity

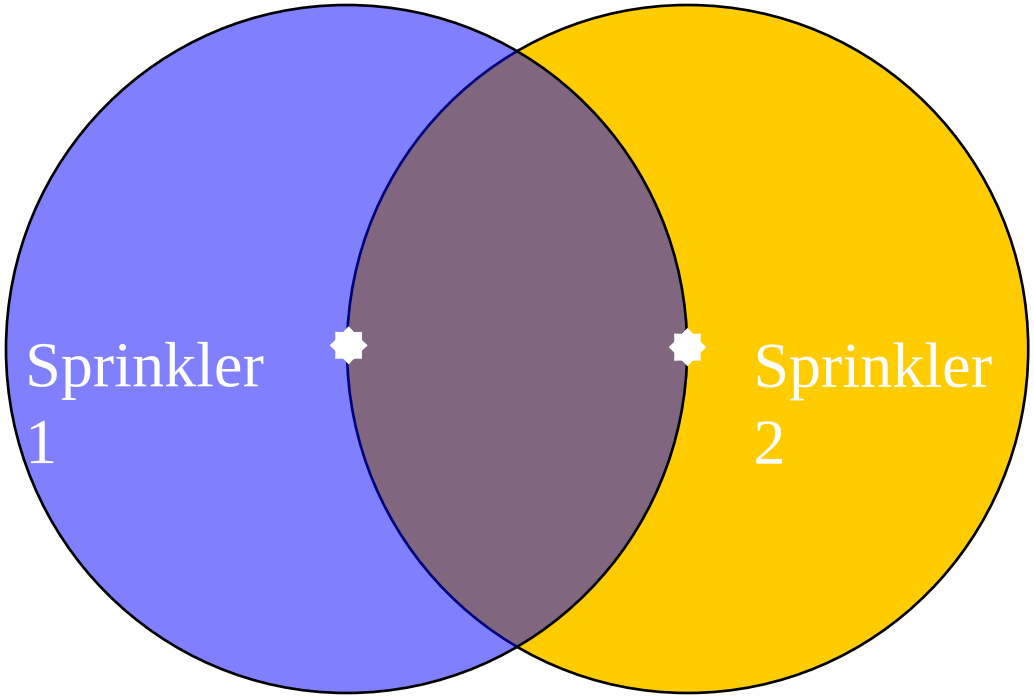
DU – how evenly water is applied (a decimal)

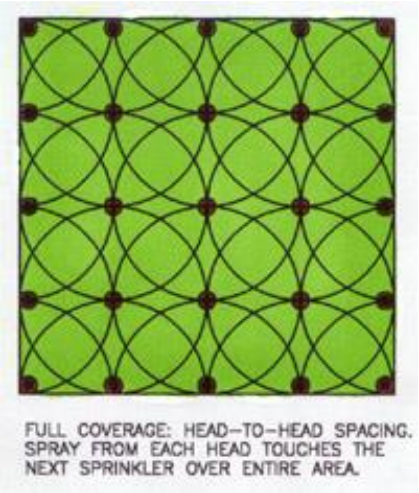
To achieve good DU

- Adjust sprinklers for head-to-head sprinkler coverage
- Eliminate common causes of poor distribution uniformity

Irrigation Efficiency

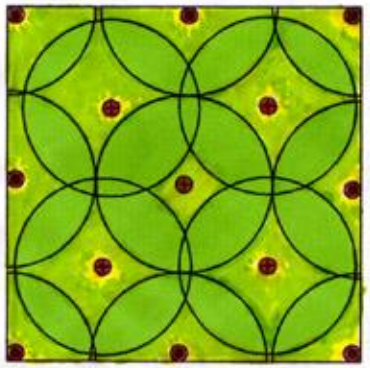
Distribution Uniformity: Head to Head Spacing = Full Coverage





Irrigation Efficiency

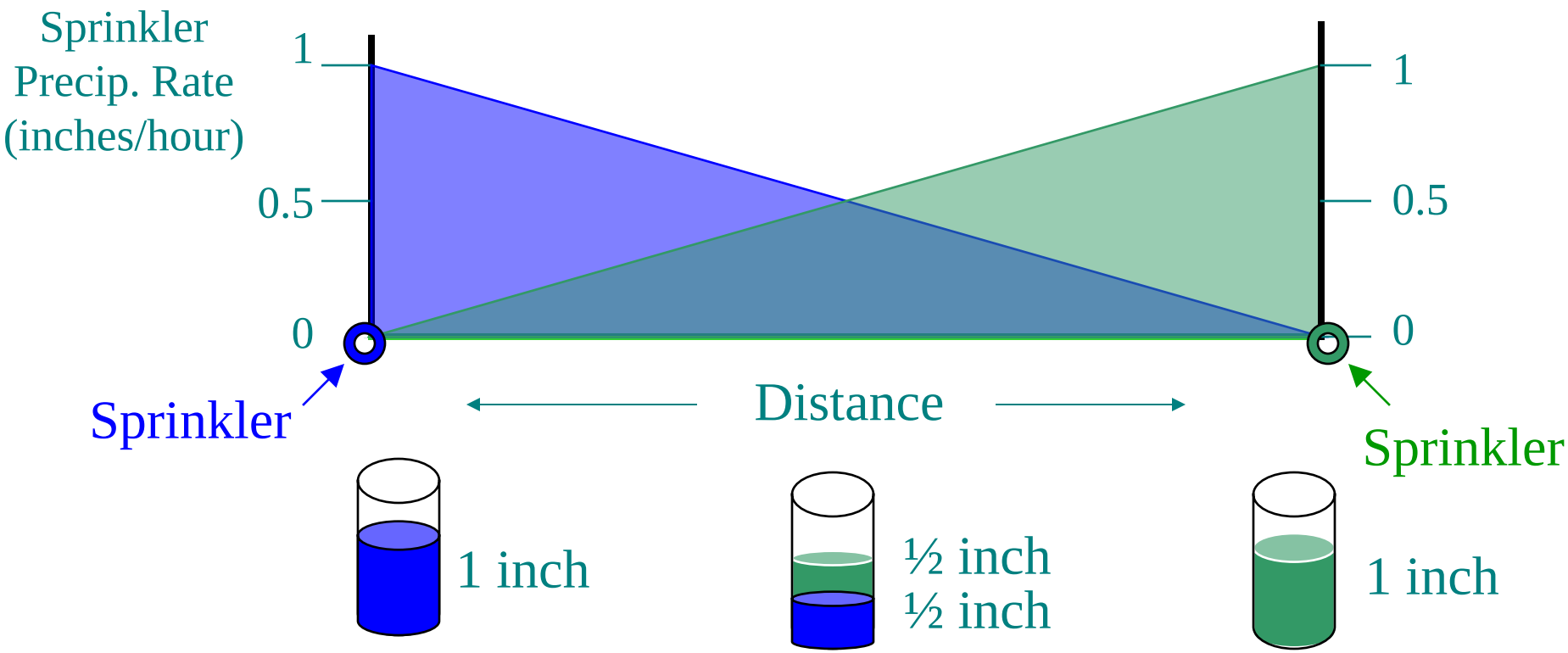
Distribution Uniformity: *No* Head to Head Spacing = *Poor* Coverage



SPACING IS NOT HEAD–TO–HEAD. NOT FULL COVERAGE. MANY WEAK SPOTS.

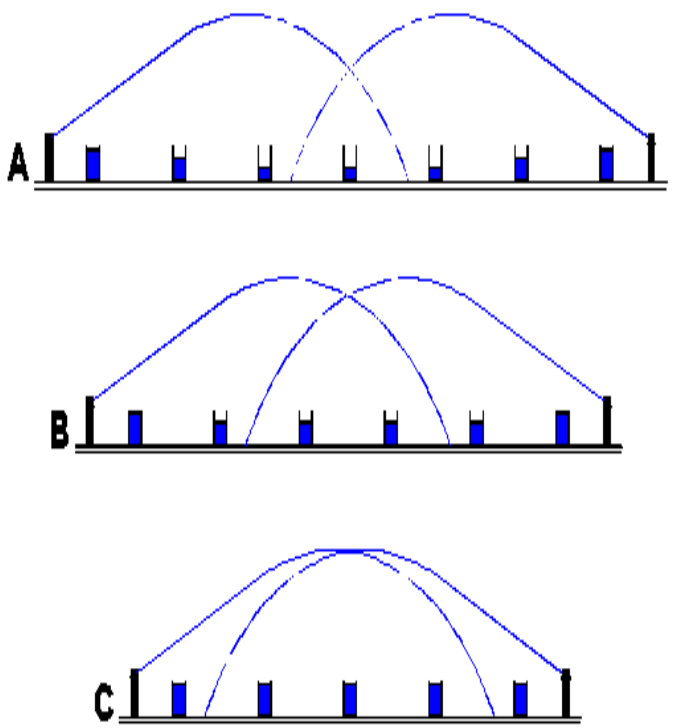
Irrigation Efficiency

Distribution Uniformity: *Head to Head Coverage*



Irrigation Efficiency

Distribution Uniformity: *Good Design = Good DU*



A. Sprinklers barely overlap & middle cups are only ½ full

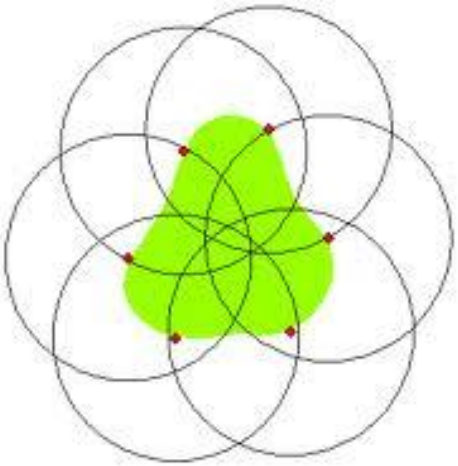
B. Sprinklers are closer but water is still not evenly applied

C. Sprinklers with head to head spacing and full cups

Graphics and text courtesy of www.IrrigationTutorials.com

Irrigation Efficiency

Distribution Uniformity: *Head to Head in "Perfect" Areas*



Irrigation Efficiency

Distribution Uniformity: *Leading Causes of Poor DU*

Improper Water Pressure

Poor Design

Poor Spacing

Distribution Uniformity: *Leading Causes of Poor DU*

Spray pattern blocked by fixtures/plants

Heads below grade

Leaning sprinkler heads

Plant Blockage

Nozzles clogged

Broken heads

Distribution Uniformity: *Water Pressure (PSI)*

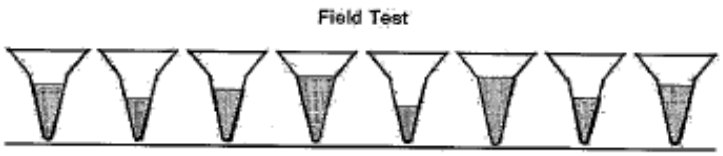
Water pressure is measured in pounds per square inch (PSI):

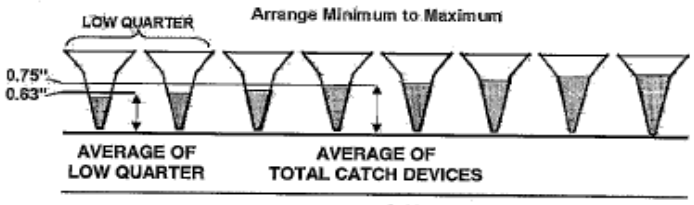
- Pressure must be calculated and adjusted to recommended specifications for each irrigation component to assure system runs properly

Distribution Uniformity: *Calculating DU_{LQ}*

DU_{lq}: the average water applied in the area receiving the least amount of water (driest area), divided by the average water applied over the total area

Formula: $DU_{lq} = \frac{\text{Avg. LQ cans}}{\text{Average of all cans}}$



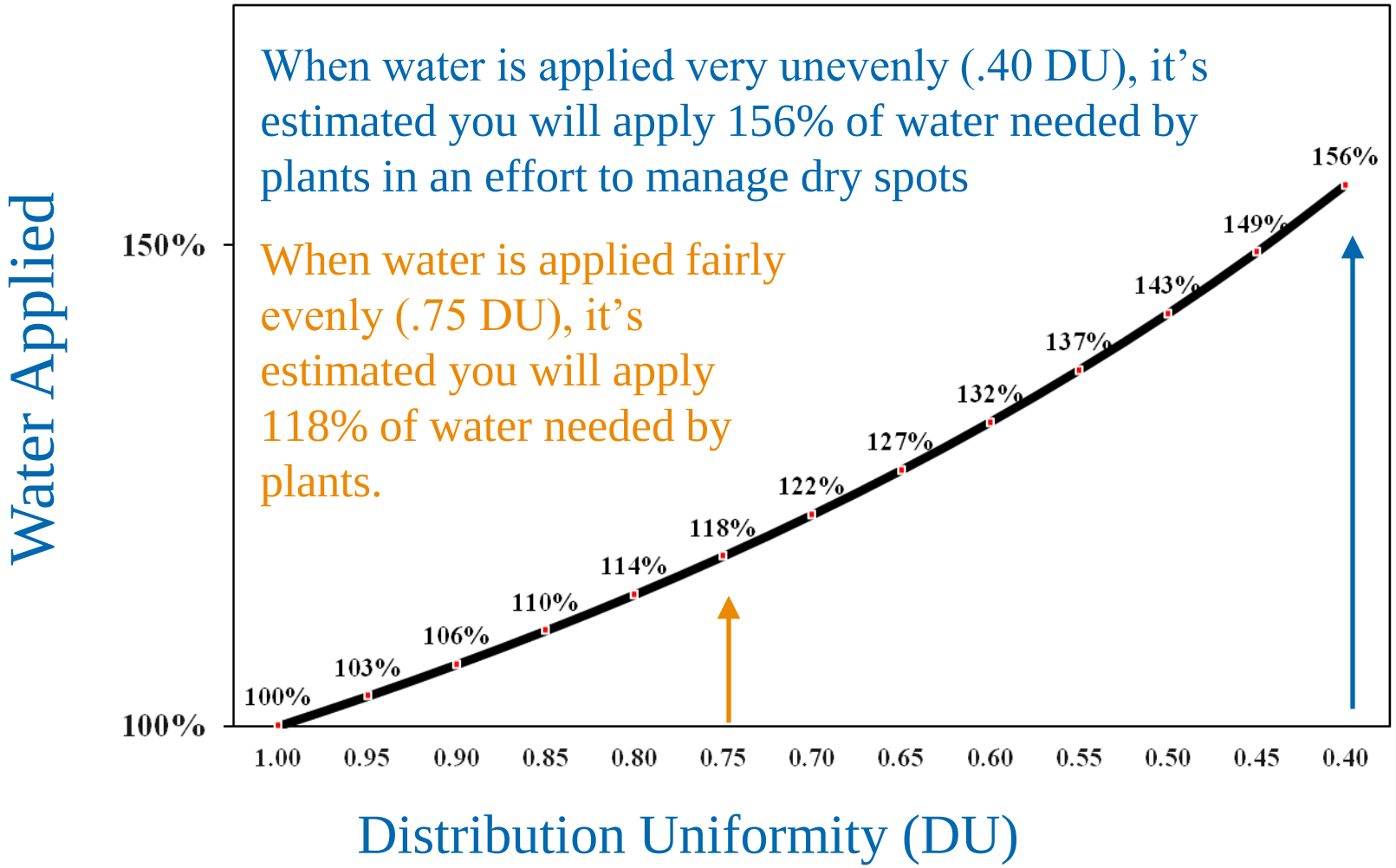


Run Time Multiplier (RTM): *Calculating RTM*

Runtime Multiplier: Adjusts the number of minutes to compensate for a lack of perfect uniformity.

Runtime Multiplier (RTM) = $$\frac{1}{(0.4 + (0.6 \times DU))}$$

Poor DU Leads to Overwatering



Keys to Irrigation Efficiency: *Precipitation Rate (PR)*

PR = How fast sprinklers apply water measured in inches per hour

To measure PR

- ✓ Manufacturer's specs
- ✓ Use the "flow rate" formula
- ✓ Do a landscape water audit
- ✓ Goal = Matched PR

Keys to Irrigation Efficiency: *Matched Precipitation Rate (PR)*

Matched PR

Arc (spray pattern)	Flow (gallons/minute)	Precip Rate (inches/hour)
Full Circle	3.70	1.83
Half Circle	1.85	1.83
Quarter Circle	0.92	1.83

Unmatched PR

Arc (spray pattern)	Flow (gallons/minute)	Precip Rate (inches/hour)
Full Circle	3.70	0.46
Half Circle	3.70	0.92
Quarter Circle	3.70	1.83

Keys to Irrigation Efficiency: *System Tune Up*

System Tune-up should be made prior to the start-up

- Check/adjust water pressure for proper irrigation system operation
- Check/adjust spray heads for head-to-head coverage
- Remove plant material that may by blocking spray heads
- Fix/replace/straighten broken irrigation components

Optimize Landscape Water Use

- Check for Leaks and Repair
- Incorporate New Technology
- Learn to Read Water Meter
- Program Timer Efficiently and Run Multiple Cycles
- Mulch
- Minimize Evaporation
- Check Soil Moisture
- Avoid Runoff on Sidewalks

Maximizing 2-3 Day Watering

- Promote Deeper Watering
- Mow Lawns Higher
- Use Cycle/Soak Method
- Use Graywater
- Minimize Pruning
- Minimize Fertilizing

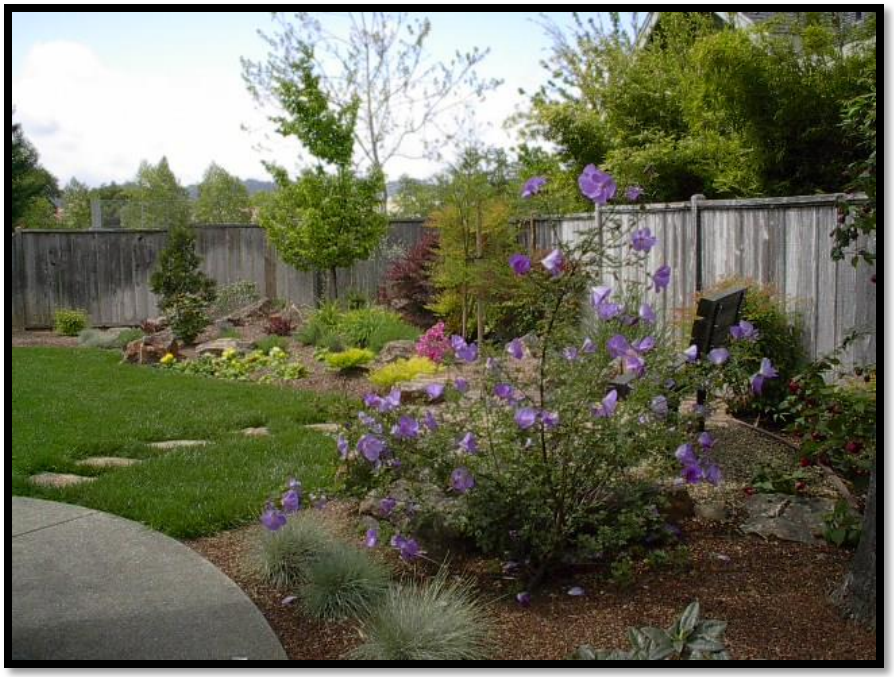
New Landscape Technology

- "Smart" Controllers
- Rain and Moisture Sensors
- Water Budgets
- Plant Material – Water Use Classification of Landscape Species (WUCOLS)
- Organic Fertilizers
- Rain Harvesting
- Graywater Use

What to do NOW!

- Efficient Irrigation Systems
- Learn to Read Water Meter
- Long Term Survivability of Landscape
- Consider Products Used Organic Fertilizers
- Rain Harvesting & Graywater
- Program Controller Efficiently

Why Was The Irrigation Controller Invented?



CONVENIENCE!

Why Use an Irrigation Controller?

- Convenience
- Efficiency
- Reliability

What is Needed for Efficient Scheduling?

- **Water Meter**
- ***Water Budget***
- ***Controller***
- ***Knowledge of Site Characteristics***
- ***Adjustments***
- ***Learn Cycle/Soak Method***

Irrigation Schedule

- **Calculate Application Rate** – how much water each sprinkler type puts out (measured in inches per a measurement of time)
- **Determine Gallons per Minute/hour** – manufacture specs or water meter reading
- **Determine How Many Gallons Per Week Needed** – multiply run times by number of days water will occur
- **Produce Irrigation Schedule**

Scheduling Guide 1

CLCA California Landscape Contractors Association

Minimum and Maximum Station Runtimes

		Spray		*Gear Rotor		*Impact Sprinkler		Stream Rotor		Rotating Nozzles	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
Soil Type	**Slope**	1.8 in/hr		.7 in/hr		.65 in/hr		.6 in/hr		.45 in/hr	
Sand	Mild	16	5	33	8	37	6	37	8	50	10
Sand	Moderate	10	5	21	8	22	6	24	8	31	10
Sand	Steep	7	5	12	8	8	6	10	8	13	10
Sandy Loam	Mild	13	5	23	8	25	6	26	8	36	10
Sandy Loam	Moderate	8	5	15	8	17	6	18	8	24	10
Sandy Loam	Steep	5	4	8	8	8	6	9	8	13	10
Loam	Mild	10	5	18	8	21	6	23	8	30	10
Loam	Moderate	7	5	12	8	12	6	14	8	19	10
Loam	Steep	4	4	8	8	7	6	8	8	11	10
Clay Loam	Mild	8	5	15	8	17	6	18	8	24	10
Clay Loam	Moderate	5	4	8	8	10	6	11	8	16	10
Clay Loam	Steep	3	3	8	8	6	6	8	8	10	10
Clay	Mild	5	4	10	8	12	6	13	8	18	10
Clay	Moderate	3	3	8	8	8	6	10	8	13	10
Clay	Steep	3	3	8	8	6	6	8	8	10	10

CAUTION: These station runtimes are approximate and are intended to be used as a guide to allow you to develop the optimum runtimes for your particular property.

*NOTE: Minimum runtimes for rotary sprinklers: The engineered rotational speed is 1 to 1 1/2 minutes per rotation of the sprinkler. Four passes or rotations are needed to apply meaningful amounts of water per cycle for full circle sprinklers. If valved separately, half circle sprinklers runtimes can be reduced 50%. 90 degree sprinklers can be reduced 75%.

Rotating Nozzles:
MP Rotator nozzles are .45 in/hr.
Rain Bird R13-18 are .70 in/hr.
Rain Bird R17-24 nozzles are .75 in/hr. at most pressures.

Flat to Mild Slope = 0 to 5 degrees **Moderate slope = 5 to 20 degrees** **Steep Slope = More than 20 degrees**

Calculated minimum precipitation per cycle as follows

Spray heads - (1.8in/hr) - @ 5minutes = .15in/cycle. @ 3 min. = .09in/cycle. **Gear Rotors** - (.7 in/hr) @ 8 min. = .0 in/cycle. **Impact Rotors** - (.65 in/hr) @ 6 min. = .065 in/cycle. **Stream Rotors** - (.60 in/hr) - @ 8 min. = .08 in/cycle. **Rotating Nozzles** - (.45 in/hr) - @ 10 min. = .075 in/cycle.

Scheduling Guide II

Irrigation Scheduling Worksheet

Enter Precipitation Rate: 1.8

Enter Station Run Time: 6

Turf

?Sports Turf?

Month	Reference ET	Season adj.	Crop k	Site k	System k	Required H2O		Minutes per week	Number of cycles/week
January	1.35	1	0.8	1	0.625	1.73		13	2
February	1.87	1	0.8	1	0.625	2.39		18	3
March	3.45	1	0.8	1	0.625	4.42		34	6
April	5.03	1	0.8	1	0.625	6.44		50	8
May	5.93	1	0.8	1	0.625	7.59		58	10
June	6.71	1	0.8	1	0.625	8.59		66	11
July	7.11	1	0.8	1	0.625	9.10		70	12
August	6.29	1	0.8	1	0.625	8.05		62	10
September	4.84	1	0.8	1	0.625	6.20		48	8
October	3.61	1	0.8	1	0.625	4.62		36	6
November	1.8	1	0.8	1	0.625	2.30		18	3
December	1.36	1	0.8	1	0.625	1.74		13	2
Totals	**49.35**					**63.17**			

Enter Precipitation Rate: 0.9

Enter Station Run Time: 6

Shrubs & Ground Cover

Month	Reference ET	Season adj.	Crop k	Site k	System k	Required H2O		Minutes per week	Number of cycles/week
January	1.35	1	0.6	1	0.625	1.30		20	3
February	1.87	1	0.6	1	0.625	1.80		28	5
March	3.45	1	0.6	1	0.625	3.31		51	8
April	5.03	1	0.6	1	0.625	4.83		74	12
May	5.93	1	0.6	1	0.625	5.69		88	15
June	6.71	1	0.6	1	0.625	6.44		99	17
July	7.11	1	0.6	1	0.625	6.83		105	18
August	6.29	1	0.6	1	0.625	6.04		93	15
September	4.84	1	0.6	1	0.625	4.65		72	12
October	3.61	1	0.6	1	0.625	3.47		53	9
November	1.8	1	0.6	1	0.625	1.73		27	4
December	1.36	1	0.6	1	0.625	1.31		20	3
Totals	**49.35**		**0.6**			**47.38**			

Sample: Controller Programming Chart

CONTROLLER PROGRAMMING CHART

CLCAV California Landscape Contractors Association

JOB NAME: ABC Mfg. **PREPARED BY:** JM

CONTROLLER: RME-12 **DESIGNATION:** A **VALVES:** WeatherMatic **MOW DAY:** Th

PROGRAM 1				PROGRAM 2				PROGRAM 3				PROGRAM 4			
STA.#	RUN TIME	AREA WATERED	SPKLR.	STA.#	RUN TIME	AREA WATERED	SPKLR.	STA. #	RUN TIME	AREA WATERED	SPKLR.	STA.#	RUN TIME	AREA WATERED	SPKLR.
1	6	Turf	spray	4	5	Shrubs & GC	spray	10	20	Raised planters	drip				
2	6	Turf	spray	6	6	Shrubs & GC	spray								
3	6	Turf	spray	8	12	Shrubs & GC	rotor								
5	6	Turf	spray	9	12	Shrubs & GC	rotor								
7	6	Turf	spray												
11	6	Turf	spray												
Hrs	0.60				0.58				0.33						
DATE	DAYS ON	START TIMES	CY/WK	DATE	DAYS ON	START TIMES	CY/WK	DATE	DAYS ON	START TIMES	CY/WK	DATE	DAYS ON	START TIMES	CY/WK
1-Mar	2-3-4-5	1am/2am/3am	12	1-Mar	3-4-5	9p/10p/11p	9	1-Mar	2-3-4-5-6	6am	5				

CY / WK = Cycles per week. Multiply number of "Days On" by number of "Start Times".

CONTROLLER PROGRAMMING CHART

JOB NAME:		WETZEL			CONTROLLER: Hunter Pro C - 9 station		DESIGNATION:			VALVES:		MOW DAY: Tuesday		PREPARED BY: PE	
														DATE: 08/11/06	
		PROGRAM A - turf				PROGRAM B - drip				PROGRAM C - Drip				PROGRAM D	
STA.#	RUN TIME	AREA WATERED	SPKLR	STA.#	RUN TIME	AREA WATERED	SPKLR	STA. #	RUN TIME	AREA WATERED	SPKLR	STA.#	RUN TIME	AREA WATERED	SPKLR
1	5	Front Lawn - South	spray	6	30	Front/South Fence Line	drip	8	15	Raised Planter Boxes	drip				
2	5	Front Lawn - North	spray	7	30	Back yard	drip								
3	5	Back Lawn - Middle	spray												
4	5	Back Lawn - Upper	spray												
6	5	Back Lawn - Lower	Spray												
TOTALS	0.41666667				1				0.25				0		
DATE	DAYS ON	START TIMES	CY/WK	DATE	DAYS ON	START TIMES	CY/WK	DATE	DAYS ON	START TIMES	CY/WK	DATE	DAYS ON	START TIMES	CY/WK
Jan				Jan				Jan				Jan			
Feb				Feb				Feb				Feb			
Mar	Su,W,F	1am,2am	6	Mar	Su	3:30am	1	Mar				Mar		WB = 40%	
Apr		WB = 60%	15	Apr		WB = 60%	4	Apr				Apr		WB = 60%	
May		WB = 75%	15	May		WB = 75%	4	May	every day	7:am/4:30pm	14	May		WB = 75%	
June	mow day?	WB = 90%	15	June		WB = 90%	4	June	every day	7am, 4:30pm	14	June		WB = 90%	
July	Su,M,W,Th,Sa	1am,2am,3am	15	July	Su,T,Th,Sa	3:30am, 5:00am	4	July	Su,Tu,Th,Sa	7:am, 4:30pm (WB	8	July		WB = 100%	
Aug		WB = 55%	5	Aug		WB = 55%	4	Aug		WB = 90%	8	Aug		WB = 55%	
Sept		WB = 65%	5	Sept		WB = 65%	4	Sept		WB = 65%	8	Sept		WB = 65%	
Oct	Su,W,F	1am,2am	6	Oct	Su,Th	3:30am	2	Oct	Su,Tu,Th	7am	3	Oct		WB = 45%	
Nov	Su,W,F	1am	3	Nov	Su	3:30am	1	Nov				Nov		WB = 25%	
Dec				Dec				Dec				Dec			

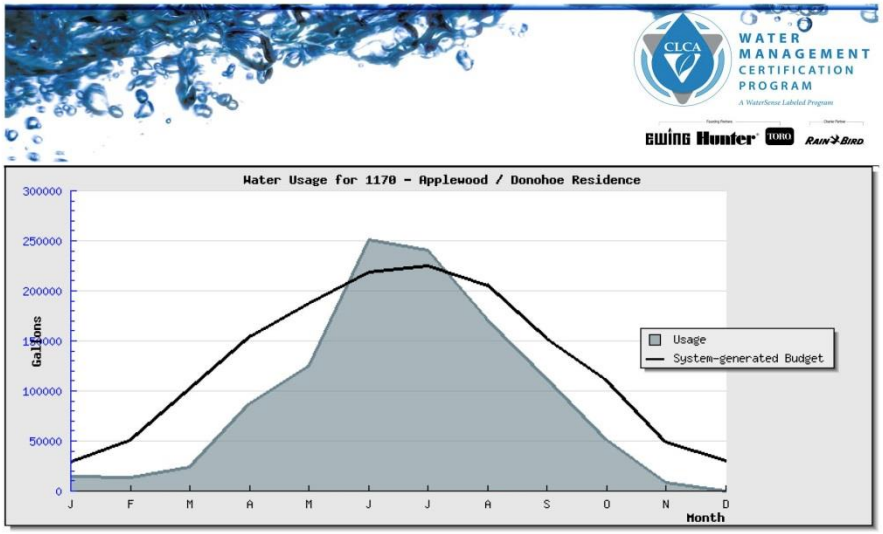
CY / WK = Cycles per week. Multiply number of "Days On" by number of "Start Times".

*** Recommended watering schedule only - should be adjusted for actual site conditions ***

Adjustments to Schedule

- Poor Sprinkler Coverage (D.U.)
- Poor Sprinkler Performance
- Run Off Occurs
- Microclimates
- Soil Type Variations
- Exposure
- Mowing Day

Monthly Report



2014 Water Use History						
Month	ETo (inches)	Water Usage (Gallons)	Water Budget (Gallons)	Over/Under (Gallons)	% Budget	% ETo
jan	0.82	15,100.00	29,258.98	-14,158.98	51.61%	45.84%
feb	1.44	13,100.00	51,384.73	-38,284.73	25.49%	22.65%
mar	2.87	23,500.00	102,417.66	-78,917.66	22.95%	20.38%
apr	4.31	87,500.00	153,802.40	-66,302.39	56.89%	50.54%
may	5.26	125,399.99	187,709.58	-62,309.59	66.81%	59.35%
jun	6.14	251,200.01	219,109.28	+32,090.73	114.65%	101.85%
jul	6.30	240,200.00	224,820.36	+15,379.64	106.84%	94.91%
aug	5.76	170,400.00	205,553.89	-35,153.89	82.90%	73.65%
sep	4.25	112,500.00	151,661.68	-39,161.67	74.18%	65.90%
oct	3.10	51,400.00	110,628.74	-59,228.74	46.46%	41.28%
nov	1.38	8,800.00	49,244.01	-40,444.01	17.87%	15.87%
dec	0.86	300.00	30,688.62	-30,388.62	0.98%	0.87%
total	42.49	1,099,400.01	1,516,294.91			
ytd	42.49	1,099,400.01	1,516,279.94	-416,879.93	72.51%	64.41%

Contractor Information

Gardenworks Inc.
P.O. Box 326
Healdsburg ,CA 95448
707-857-2050

Site Managers	
Peter Estournes	PETER.ESTOURNES

Site Description

1170 - Applewood / Donohoe Residence
4566 Vine Hill Road
Sebastopol,CA 95472

Landscaped Area: 64400 square feet

Site Notes

100% ETo =1,706,808.88Gallons
ETo used is Applewood / Donohoe=42.49"

Crop	Square Footage	Crop k	Effective DU	Annual Budgeted Water
Cool Season Turf	28000	0.80	0.650	913,345.81
Shrubs and Trees	36400	0.50	0.800	602,949.10

Definitions

Budget:
The predicted amount of water needed to maintain your site in a healthy and viable condition. It is based upon square footage, type of plant materials, and local climate.

H.C.F:
One hundred cubic feet. The standard measure of water equal to 748 gallons. May also be expressed as C.C.F. or a "Unit" of water.

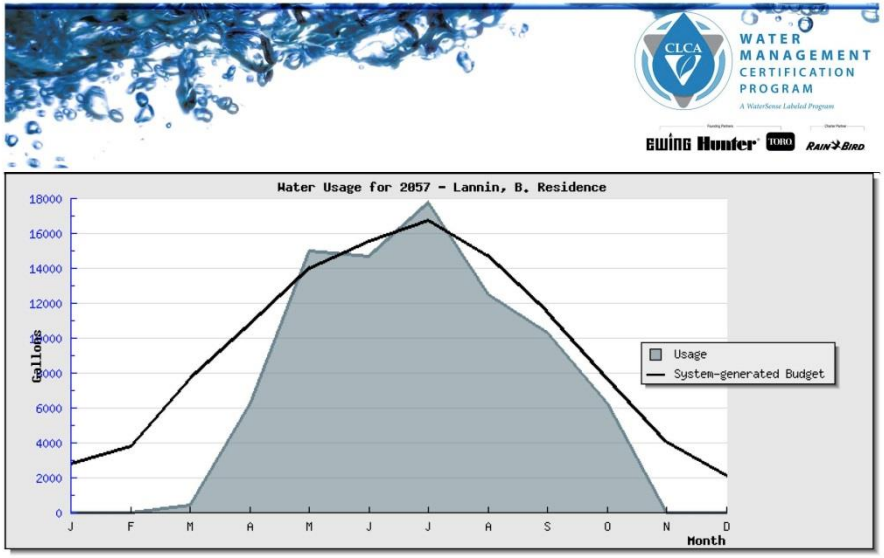
ETo:
Evapotranspiration is the combined process of water loss by evaporation and water transfer to the air through plant tissues. Reference Evapotranspiration (ETo) is a term used to describe the evapotranspiration rate from a known surface, such as grass or alfalfa.

Under/Over:
A comparison of the budgeted water to the actual consumption. Expressed in C.C.F. A negative number means that less than the budgeted amount of water was applied to the landscape.

% of Budget Used:
The percentage relationship between the budgeted amount and the actual usage. 105% would mean that 105% of the budget was used (5% more than the budgeted amount of water). The year-to-date percentage tells you how much of the cumulative budget through the current month has been used. The annual percentage tells you how much of the entire yearly budget has been used.

% of E.T. Used:
The relationship between 100% of E.T. and the actual amount of water used. It is calculated on a month-by-month basis as well as year-to-date.

Monthly Report



2014 Water Use History						
Month	ETo (inches)	Water Usage (Gallons)	Water Budget (Gallons)	Over/Under (Gallons)	% Budget	% ETo
jan	1.24	0	2,791.92	-2,791.92	0	0
feb	1.68	0	3,787.43	-3,787.43	0	0
mar	3.41	439.34	7,687.13	-7,247.78	5.72%	2.65%
apr	4.80	6,266.71	10,823.35	-4,556.65	57.90%	26.88%
may	6.20	15,029.34	13,974.55	+1,054.79	107.55%	49.91%
jun	6.90	14,656.71	15,553.89	-897.18	94.23%	43.74%
jul	7.44	17,729.34	16,773.95	+955.39	105.70%	49.07%
aug	6.51	12,489.34	14,678.14	-2,188.80	85.09%	39.50%
sep	5.10	10,332.71	11,497.01	-1,164.30	89.87%	41.72%
oct	3.41	6,223.34	7,687.13	-1,463.78	80.96%	37.58%
nov	1.80	0	4,056.89	-4,056.89	0	0
dec	0.93	0	2,095.81	-2,095.81	0	0
total	49.40	83,166.82	111,407.19			
ytd	49.42	83,166.82	111,407.19	-28,240.36	74.65%	34.65%

Contractor Information

Gardenworks Inc.
P.O. Box 326
Healdsburg ,CA 95448
707-857-2050

Site Managers	
Peter Estournes	PETER.ESTOURNES

Site Description

2057 - Lannin, B. Residence
2200 Toyon Drive
Healdsburg,CA 95448

Landscaped Area: 7786 square feet

Site Notes

100% ETo =239,912.92Gallons
ETo used is Copy of Sonoma Corridor=49.40"

Crop	Square Footage	Crop k	Effective DU	Annual Budgeted Water
Drought Resistant and Natives	6940	0.30	0.600	106,968.56
Pool, Pond, Water Feature	756	0.80	0.000	0.00
Cool Season Turf	90	0.80	0.500	4,438.62

Definitions

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Accessories For More Efficiency

- Rain Shut Off
- Soil Moisture Sensors
- Flow Sensor
- Hunter SolarSync System
- Soil Probe
- Pressure Gauge for Sprinkler Heads
- Remote Control

Quick Tips

- **Read Water Meter Monthly (minimum)**
- **Check for Leaks and Make Adjustments**
- **Check Soil Moisture**
- **Water Budgeting**
- **Avoid Run Off**
- **Install Rain Shut Off**

Gardenworks Inc.

707.433.7368
www.gardenworks-inc.com

CLCA

The California Landscape Contractors Association

www.clca.org

Some Material Courtesy of QWEL and CLCA