Irrigation Scheduling Using Stress Threshold RDI Irrigation Method

Determine Production Goals

Select a method to begin irrigation: Stress Threshold

Assess vineyard canopy coverage

Select an RDI %

Calculate full potential vineyard water use

Calculate the irrigation volume to apply using the RDI %

Vineyard Site Conditions (mature vineyard)

- Variety/rootstock ---- Cabernet Sauvignon/Freedom
- Site ---- Lodi, CA
- CIMIS Station ---- # 166
- Vine spacing ---- 7 × 11 feet
- Canopy (trellis) ---- Bilateral cordon with T top

Soil Resource

- Soil Sandy loam
- Root zone 8 feet depth
- Root zone total soil moisture at bud break --- 16.0 inches
- Root zone soil moisture at the threshold --- 12.4 inches
- Root zone soil moisture at harvest (previous year) --- 10.0 inches

Calculated values based on Site Conditions and Soil Resources:

- Vines per acre 566
- Sq ft per vine 77
- Gross application rate 0.021 in/hr
- Soil available water (between bud break and harvest) 6.0 in.
- Soil available water (between the threshold and harvest) 2.4 in.

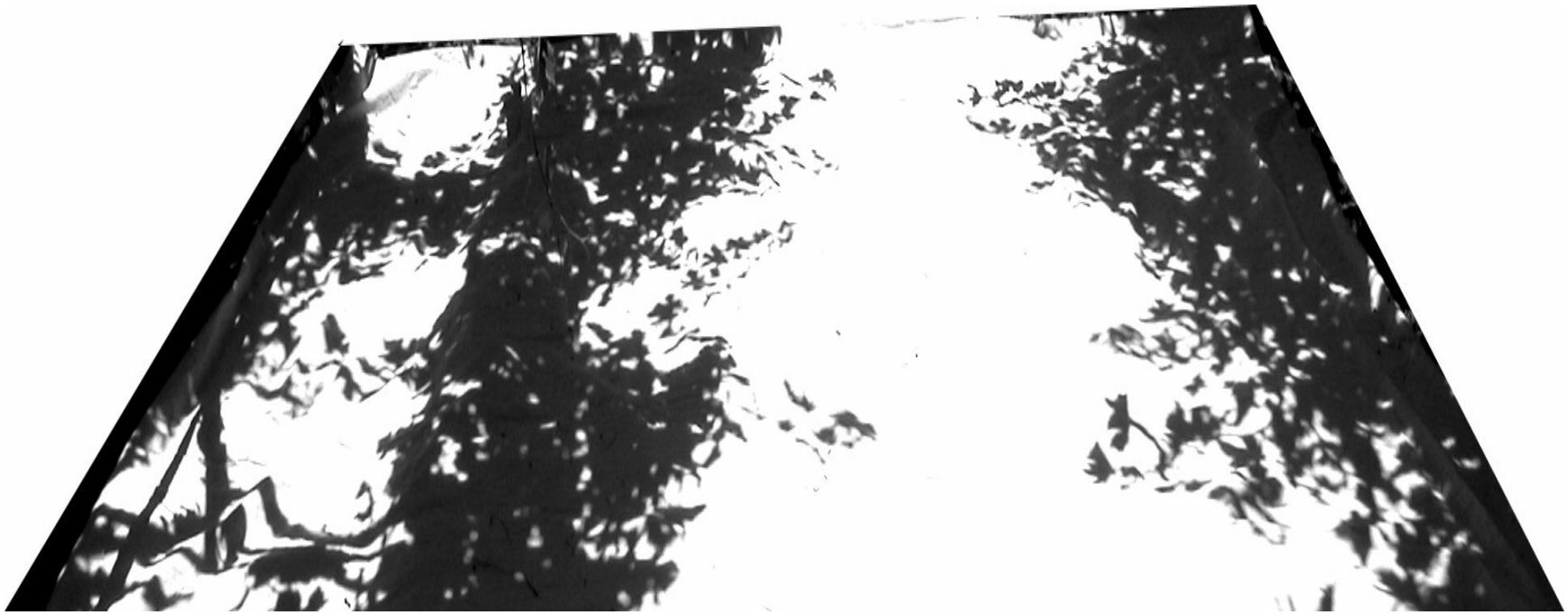
Irrigation Site Conditions and Decisions

- Irrigation System — Drip
  - Emitter Flow Rate — 1.0 gallon/hour
  - Emitters per vine — One
- Harvest Date (est.) — October 1st
- Stress Threshold — -13 bars
- Regulated deficit (RDI %) — 50%
- Threshold date — July 8th
- Post harvest irrigation — One month estimated full potential water use (all of October)

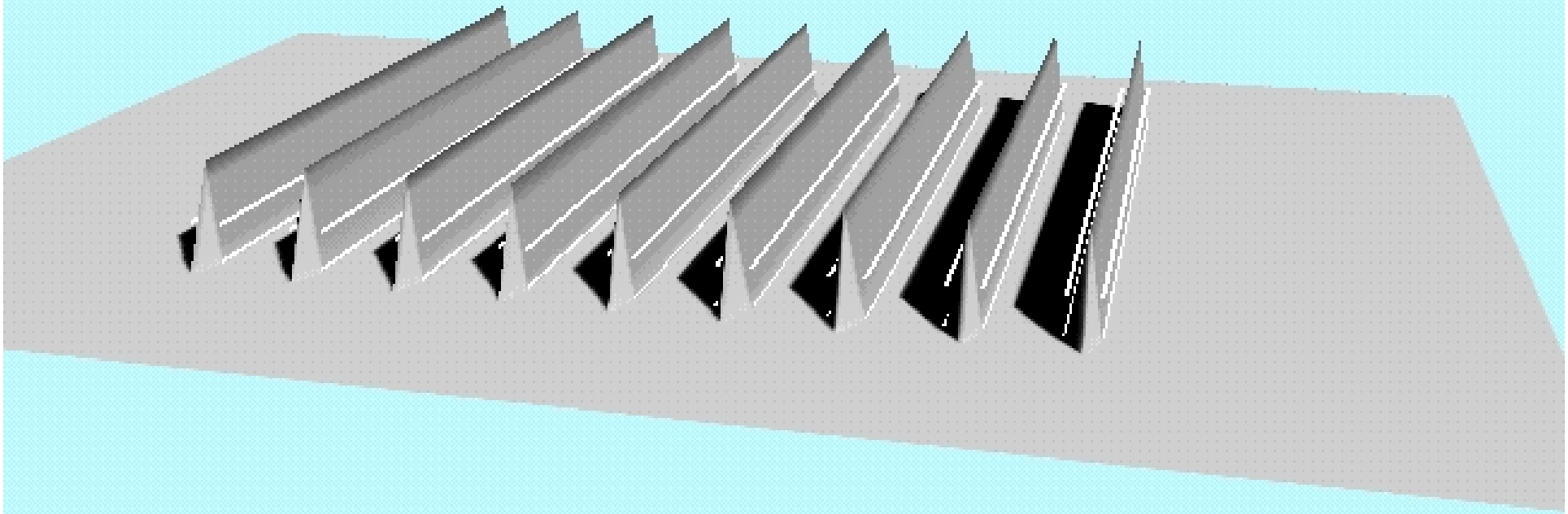

Stress Threshold
-13 bars


Land surface shaded ---- 40 %
Covercrop ---- None

Shaded Area = 40%



Row Direction



Mike Bobbitt & Associates
http://www.mikebobbitt.com/

Select an RDI %

Regulated Deficit Irrigation percentage selected = 50%

Estimating Full Potential Water Use Using Historical Averages

- ETo *Historical*
  - Use Chart in Appendix
  - Use Monthly averages from a CIMIS station
  - Download all the station data and make your own daily average

Monthly Historical ETo Averages

Station Id	Station Name	Region	Jan	Feb	Mar	Apr	May	Jun
166	Lodi West	San Joaquin Valley	0.79	1.55	3.28	5.17	6.58	7.51

Jul	Aug	Sep	Oct	Nov	Dec	Total
7.87	6.85	5.11	3.29	1.54	0.76	50.3

Lodi, CA CIMIS Stations

ETo *Historical*

42 and # 166

	Inches		Inches
January 1-7	0.19	July 1-7	1.86
January 8-14	0.20	July 8-14	1.82
January 1-21	0.29	July 15-21	1.72
January 22-28	0.30	July 22-28	1.69
January 29-Feburary 4	0.34	July 29 to August 4	1.68
February 5-11	0.40	August 5-11	1.63
February 12-18	0.56	August 12-18	1.56
February 19-25	0.63	August 19-25	1.49
February 26-March 3	0.61	August 26 to September 1	1.45
March 4-10	0.71	September 2-8	1.37
March 11-17	0.80	September 9-15	1.23
March 18-24	0.93	September 16-22	1.17
March 25-31	1.10	September 23-29	1.05
April 1 - 7	1.14	September 30 to October 6	0.97
April 8-14	1.28	October 7-13	0.88
April 15-21	1.24	October 14-20	0.78
April 22-28	1.43	October 21-27	0.66
April 29-May 5	1.57	October 28 to November 3	0.54
May 6-12	1.58	November 4 to 10	0.50
May 13-19	1.59	November 11 to 17	0.40
May 20-26	1.67	November 18-24	0.32
May 21-June 2	1.67	November 25-December 1	0.34
June 3-9	1.74	December 2-8	0.26
June 10-16	1.82	December 9-15	0.24
June 17-23	1.85	December 16-22	0.22
June 24-30	1.80	December 23-29	0.21
		December 30-31(partial week)	0.05

www.cimis.water.ca.gov

CIMIS

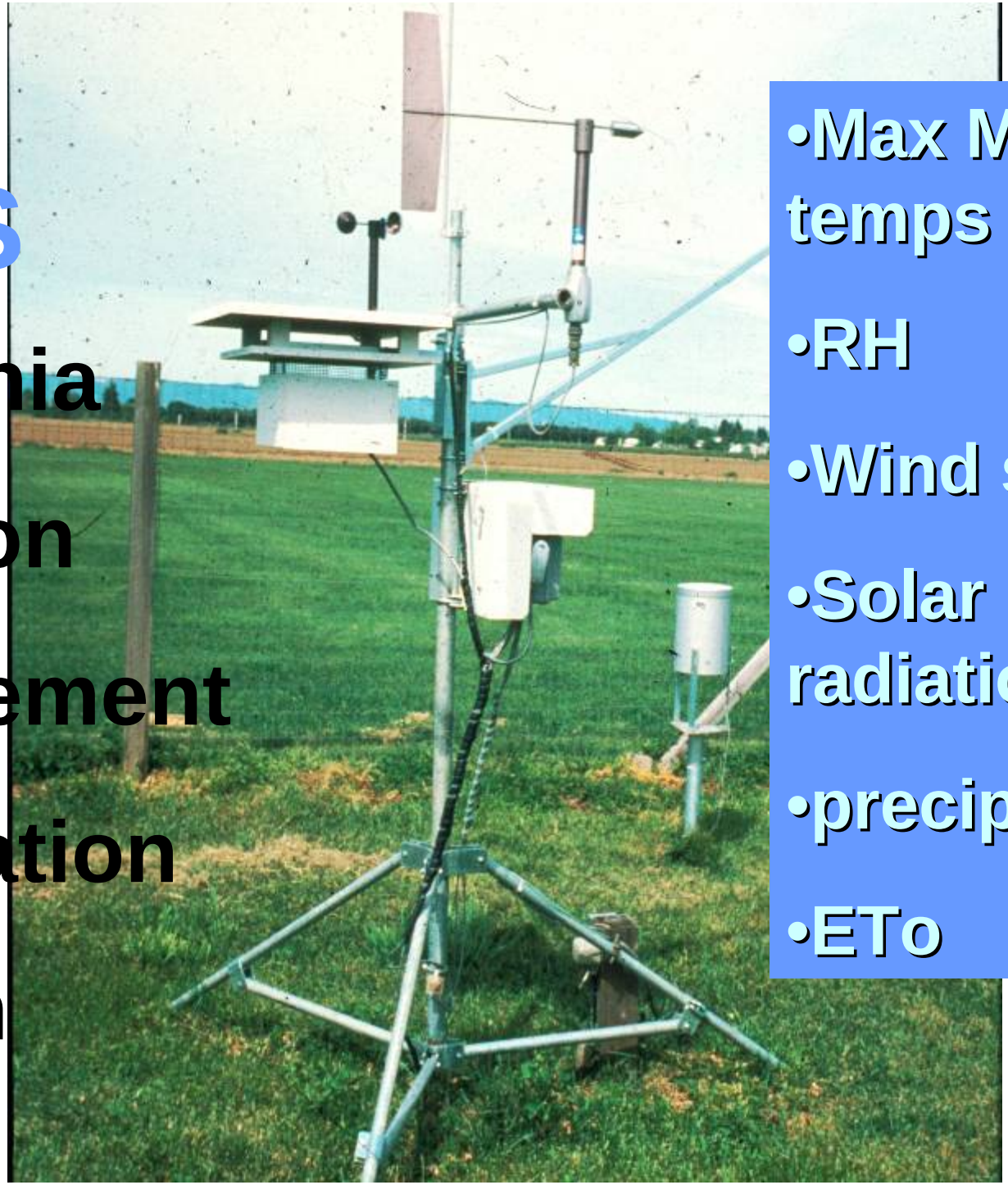
California

Irrigation

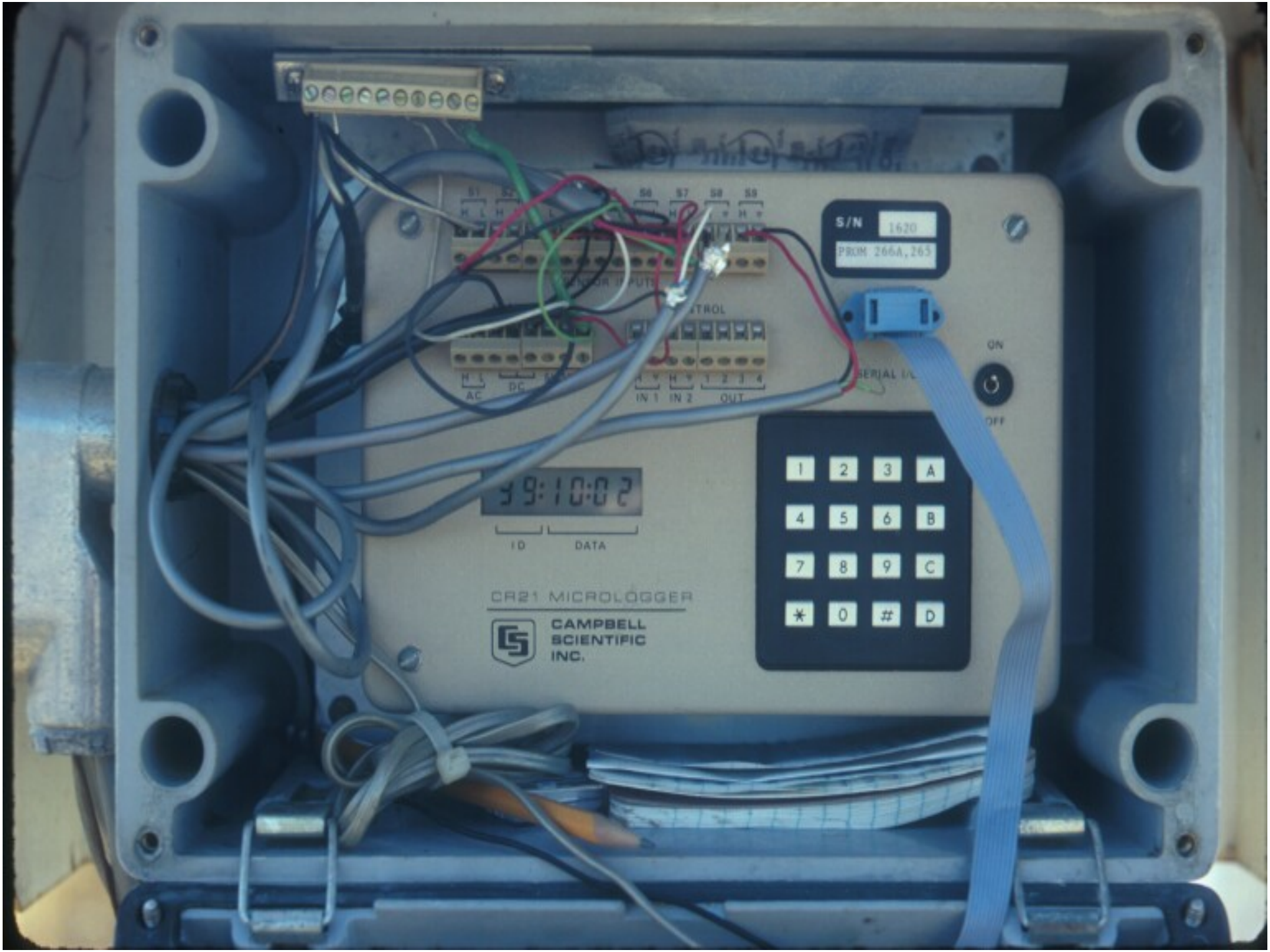
Management

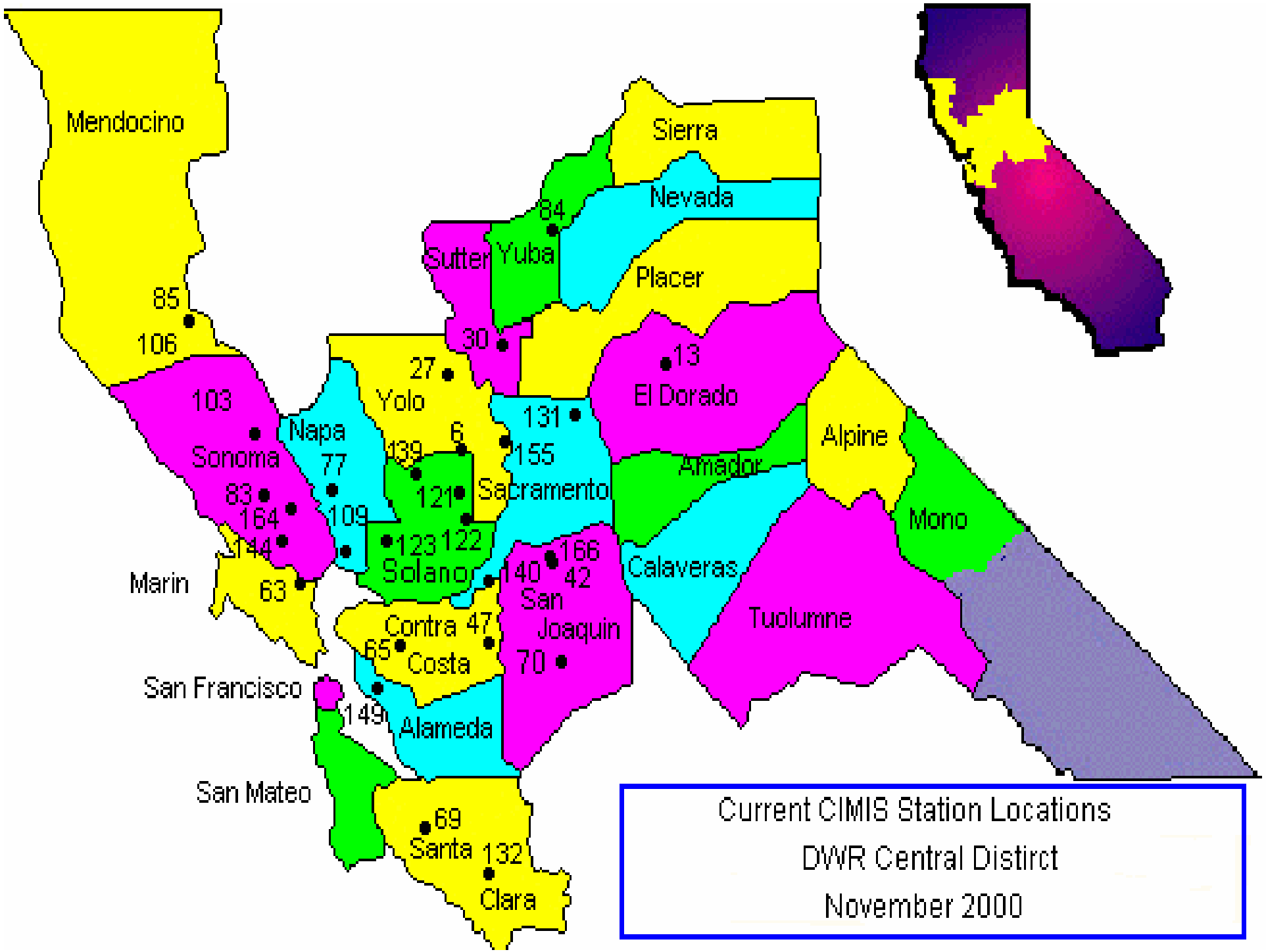
Information

System



- Max Min temps
- RH
- Wind speed
- Solar radiation
- precipitation
- ETo


S/N 1620
PROM 266A,265
ON
OFF
1 2 3 A
4 5 6 B
7 8 9 C
* 0 # D
ID
DATA
CR21 MICROLOGGER
CAMPBELL SCIENTIFIC INC.


Mendocino
Sierra
Nevada
84
Sutter
Yuba
Placer
85
106
30
27
13
103
Yolo
El Dorado
131
Napa
6
Alpine
139
155
Amador
Sonoma
77
121
Sacramento
83
164
109
Mono
144
123
122
166
Marin
Solano
140
42
Calaveras
63
San
Joaquin
Contra
47
Tuolumne
65
Costa
70
San Francisco
149
Alameda
San Mateo
69
Santa
132
Clara
Current CIMIS Station Locations
DWR Central Distirct
November 2000

CIMIS

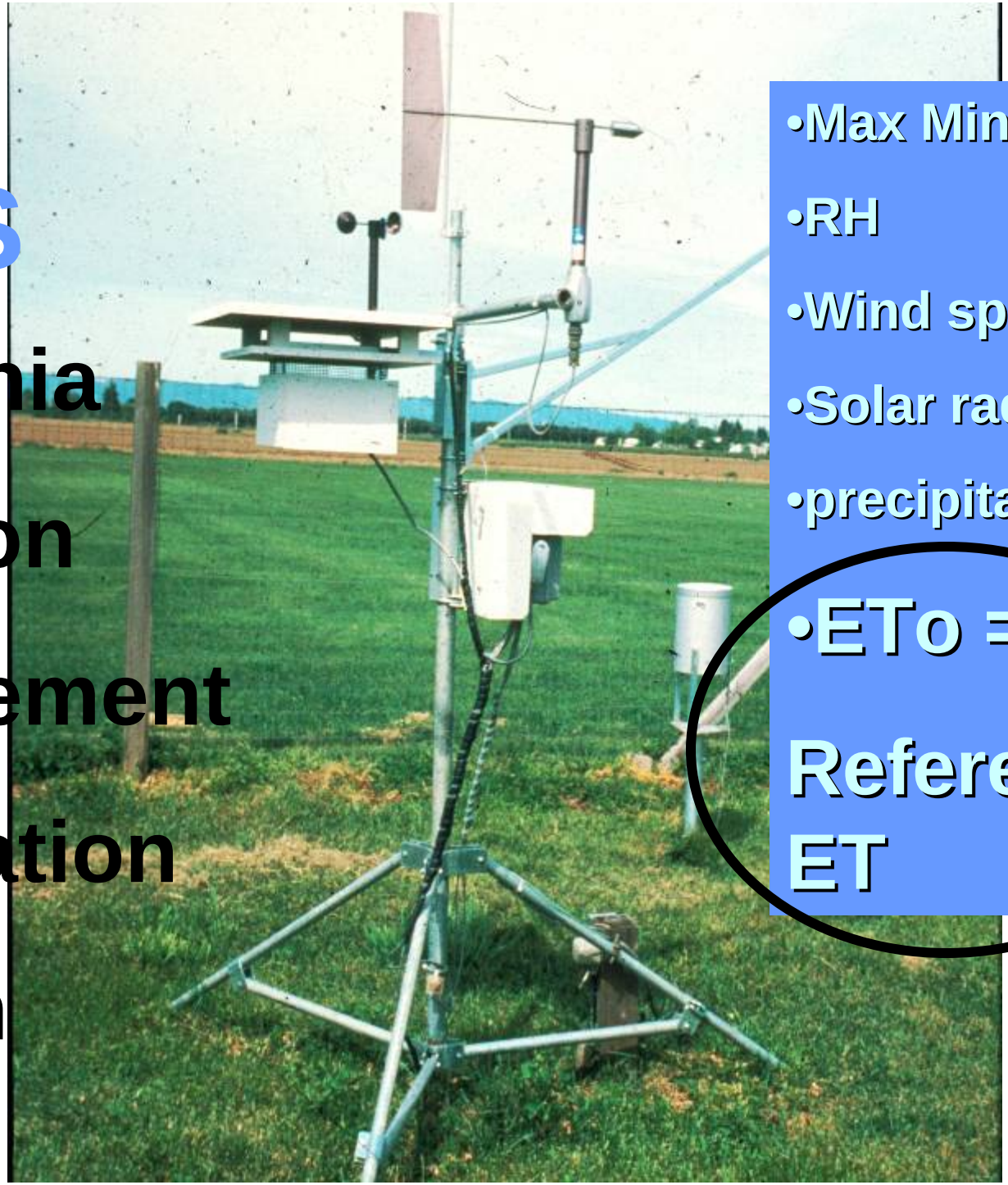
California

Irrigation

Management

Information

System



- Max Min temps
- RH
- Wind speed
- Solar radiation
- precipitation
- ETo = Reference ET

Evapotranspiration Reference (ETo)
Rainfall

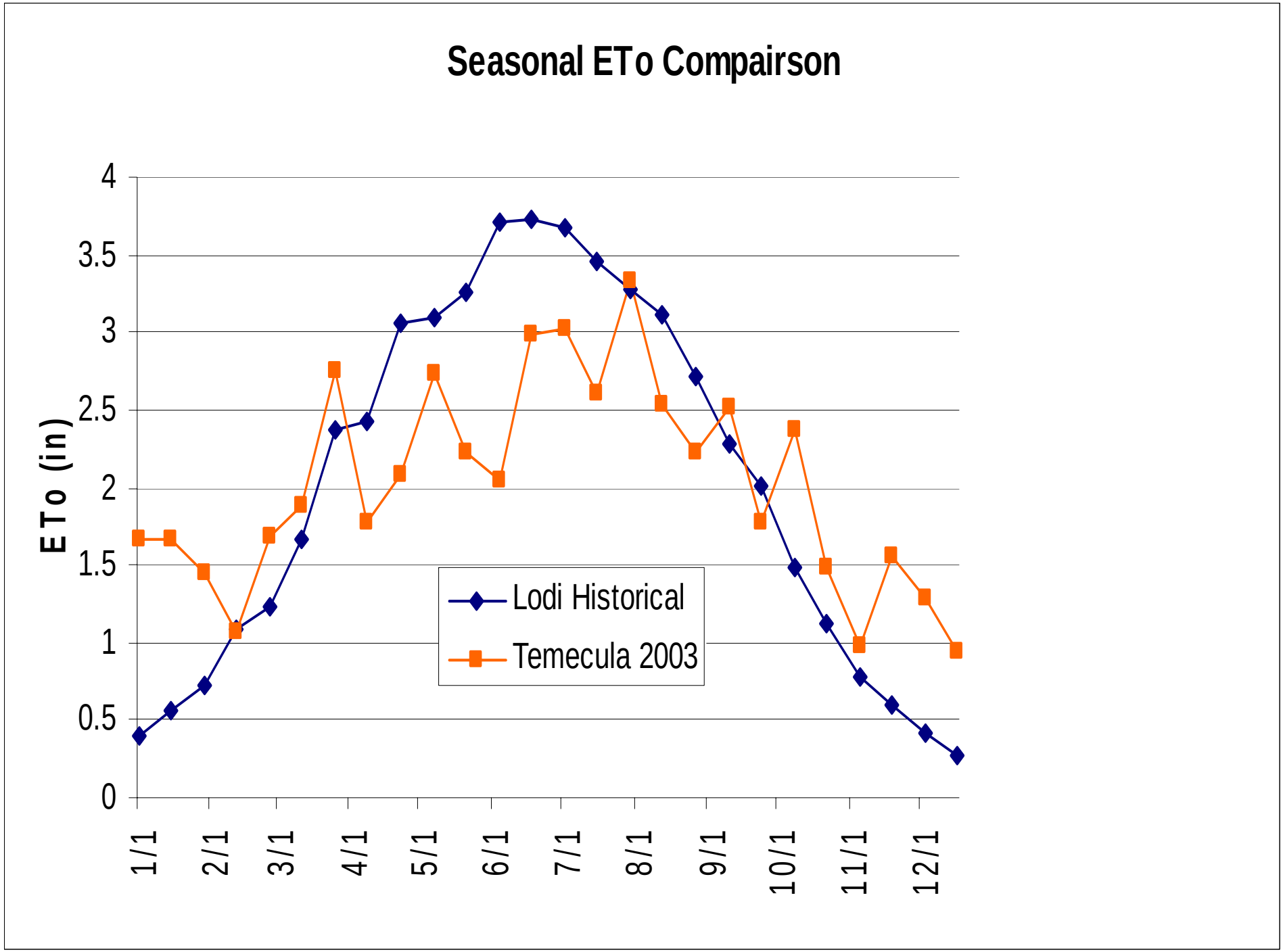
www.cimis.water.ca.gov

Data

CIMIS DATA PAGE

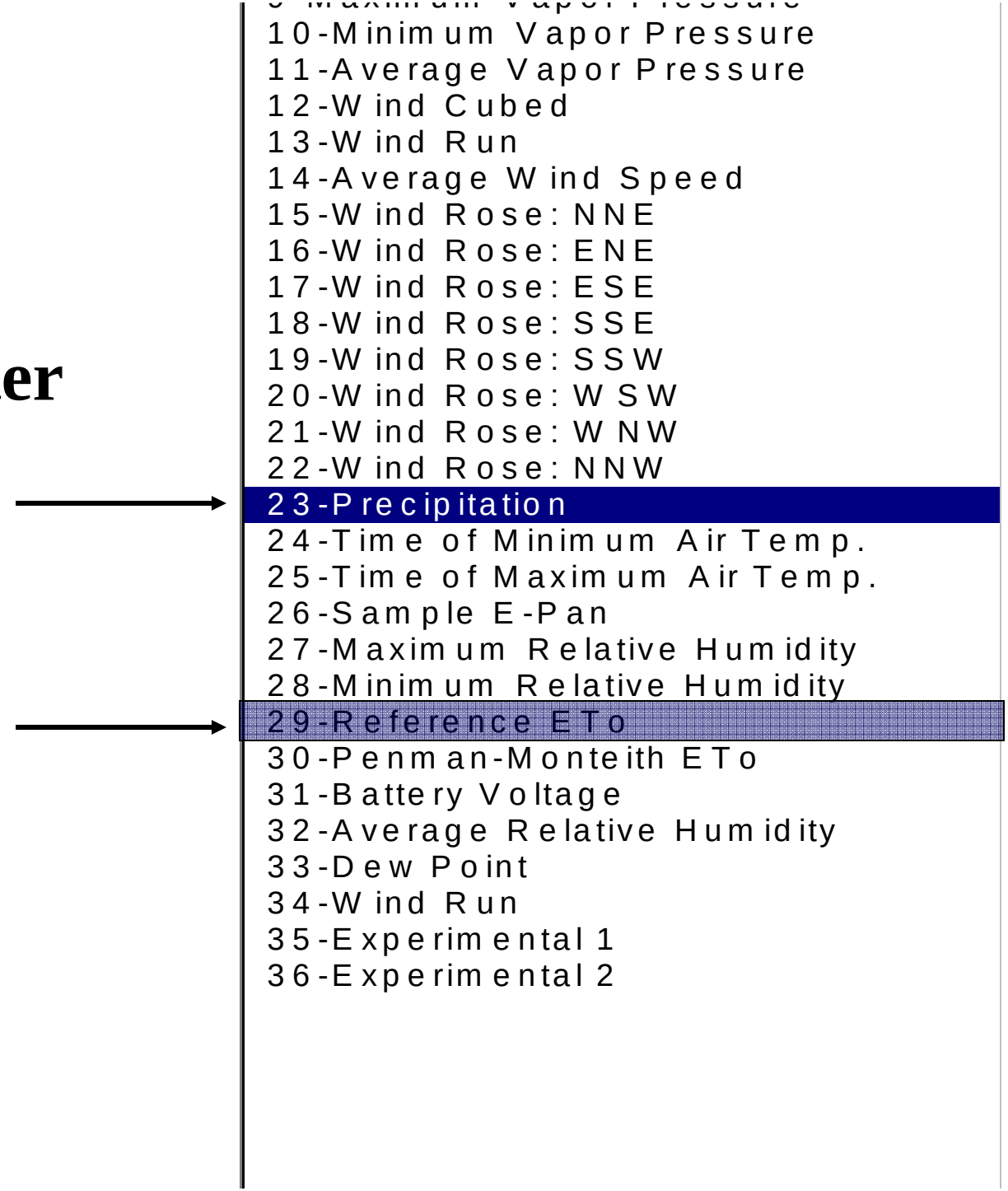
The **Data** page enables users to:

- View daily and monthly sample reports;
- Create and edit a user account;
- Retrieve CIMIS data;
- Read important information on CIMIS quality control;
- Read detailed information on CIMIS data types, formats, and sizes;
- View the weather station list.


Seasonal ETo Compairson
ETo (in)
4
3.5
3
2.5
2
1.5
1
0.5
0
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
Lodi Historical
Temecula 2003

Weather Stations

Select Parameter



Enter the beginning and ending date for your report

Specify date range: The default setting for date range is the previous 7 days.

Start Date: July 8 2006

End Date: July 14 2006

Select reporting method.
Click here for details.

Web Report
PDF
CSV with Headers
CSV without Headers
(non-report format)
XML

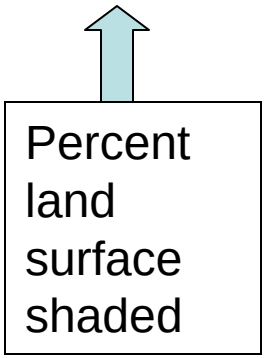
CIMIS CSV with headers output

Stn Id	Station	Region	Date	Jul	qc	Precip (in)	qc	CIMIS ETo (in)
166	Lodi West	San Joaquin Valley	7/8/2006	189	*	0	*	0.28
166	Lodi West	San Joaquin Valley	7/9/2006	190	*	0	*	0.27
166	Lodi West	San Joaquin Valley	7/10/2006	191	*	0	*	0.25
166	Lodi West	San Joaquin Valley	7/11/2006	192	*	0	*	0.26
166	Lodi West	San Joaquin Valley	7/12/2006	193	*	0	*	0.26
166	Lodi West	San Joaquin Valley	7/13/2006	194	*	0	*	0.24
166	Lodi West	San Joaquin Valley	7/14/2006	195	*	0	*	0.26
					Sum	0		1.82

Calculate Full Potential Water Use

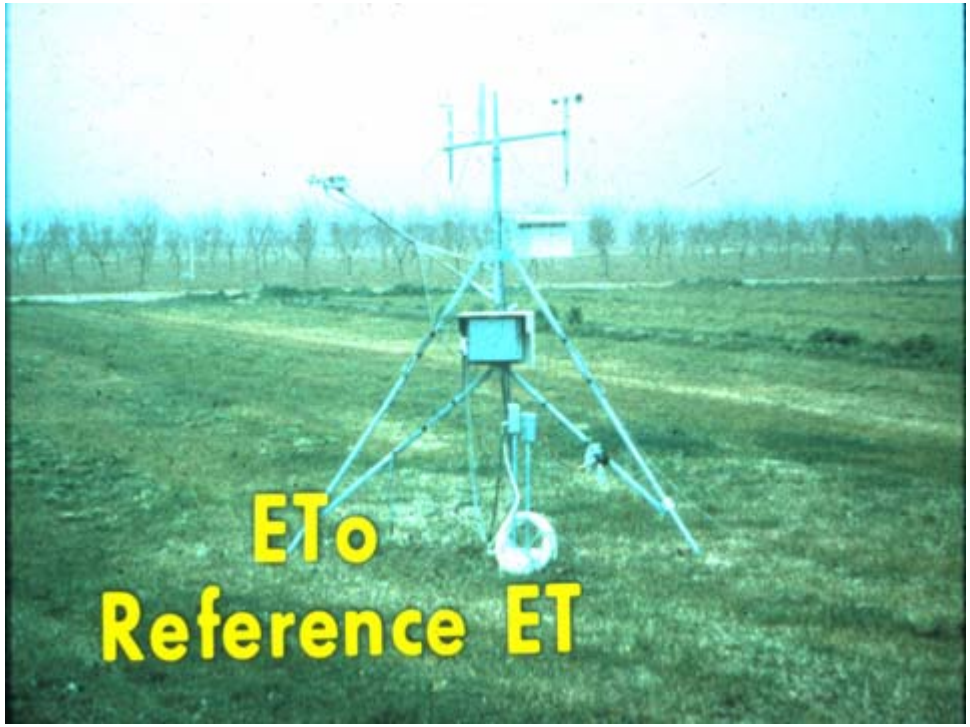
Crop Coefficient (Kc)

Kc = 0.40 x 1.7 = 0.68



Calculate Full Potential Water Use Using the Historical Average ETo and Kc

- ETo x Kc = Full Potential Water Use
- Use weekly summed data



Date	A = Historical Eto[a]	B = Crop Coefficient[b]	C = A x B: Potential Water Use
Period	Inches/Period	Kc	(in)
Jly 8-14	1.82	0.68	1.24
Jly 15-21	1.720	0.68	1.17
Jly 22-28	1.692	0.68	1.15
Jly 29 to Aug 4	1.676	0.68	1.14
Aug 5-11	1.626	0.68	1.11
Aug 12-18	1.556	0.68	1.06
Aug 19-25	1.494	0.68	1.02
Aug 26 to Sept 1	1.448	0.68	0.98
Sept 2-8	1.368	0.68	0.93
Sept 9-15	1.225	0.68	0.83
Sept 16-22	1.171	0.68	0.80
Sept 23-29	1.054	0.68	0.72
Sept 30 to Oct 6	0.974	0.68	0.66
Oct 7-13	0.883	0.68	0.60
Oct 14-20	0.779	0.68	0.53
Oct 21-27	0.660	0.68	0.45
Oct 28 to Nov 3	0.540	0.68	0.37

Total		14.75

Calculating the Water to Apply Using the Regulated Deficit %

- Full Potential Water Use x RDI %

Date	C = A x B: Potential Water Use	D = RDI coefficient[c]	G = C x D : Net Irrigation Application
Period	(in)	RDI %	(in)
Jly 8-14	1.24	0.5	0.62
Jly 15-21	1.17	0.5	0.58
Jly 22-28	1.15	0.5	0.58
Jly 29 to Aug 4	1.14	0.5	0.57
Aug 5-11	1.11	0.5	0.55
Aug 12-18	1.06	0.5	0.53
Aug 19-25	1.02	0.5	0.51
Aug 26 to Sept 1	0.98	0.5	0.49
Sept 2-8	0.93	0.5	0.47
Sept 9-15	0.83	0.5	0.42
Sept 16-22	0.80	0.5	0.40
Sept 23-29	0.72	0.5	0.36
Sept 30 to Oct 6	0.66	1	0.66
Oct 7-13	0.60	1	0.60
Oct 14-20	0.53	1	0.53
Oct 21-27	0.45	1	0.45
Oct 28 to Nov 3	0.37	1	0.37
Total	14.75		8.68

Adjusting the Schedule for the Current Season's Soil Water Storage and Climate

- Replace Historical ETo with current year values
- Add soil water extraction from the threshold
- Account for effective rainfall *after the threshold*

Add soil water extraction from the threshold

Soil Water Reservoir

- Texture
- Depth
- Winter Rain Quantity
- Alternative Sources
  - Water Table
  - Spring Rains
- Root Extensiveness

By irrigation start these factor are minimized

Soil Moisture Measurement

- Quantitative (quantity)
- Qualitative (status)

Quantitative Moisture Measurement Methods

- Gravimetric / Volumetric Soil Sampling
- Neutron Moisture Meter
- Dielectric Moisture Sensors
  - Capacitance Probes
  - Frequency Domain Reflectometry (FDR)

Soil Moisture

TableH-1. Water content typical of a 7 ft depth sandy loam soil in Lodi, California

		inches	*inches*
Total Moisture			
A – Bud Break		*16.0*	
B – Irrigation start		*12.4*	
C – Harvest		*10.0*	
Available Water			
Bud Break	*A – C*		*6.0*
Irrigation Start	*B – C*		*2.4*

Date	C = A x B: Potential Water Use	D = RDI Coefficient[c]	E = Soil Contribution	F = Effective Rainfall[d]	G = [(C x D) - E - F]: Net Irrigation Amount
Period	(in)	RDI %	(in)	(in)	(in)
Jly 8-14	1.24	0.5	0.2	0	0.42
Jly 15-21	1.17	0.5	0.2	0	0.38
Jly 22-28	1.15	0.5	0.2	0	0.38
Jly 29 to Aug 4	1.14	0.5	0.2	0	0.37
Aug 5-11	1.11	0.5	0.2	0	0.35
Aug 12-18	1.06	0.5	0.2	0	0.33
Aug 19-25	1.02	0.5	0.2	0	0.31
Aug 26 to Sept 1	0.98	0.5	0.2	0	0.29
Sept 2-8	0.93	0.5	0.2	0	0.27
Sept 9-15	0.83	0.5	0.2	0	0.22
Sept 16-22	0.80	0.5	0.2	0	0.20
Sept 23-29	0.72	0.5	0.2	0	0.16
Sept 30 to Oct 6	0.66	1		0	0.66
Oct 7-13	0.60	1		0	0.60
Oct 14-20	0.53	1		0	0.53
Oct 21-27	0.45	1		0	0.45
Oct 28 to Nov 3	0.37	1		0.32	0.05
Total	14.75		2.40		5.96

Account for effective rainfall after the threshold

Effective Rainfall

- More than 3x daily ETo

- Rainfall = 0.65 in
- Effective Rainfall =

$$[0.65 - 0.25] \times 0.8 = 0.32 \text{ in}$$

Date	C = A x B: Potential Water Use	D = RDI Coefficient[c]	E = Soil Contribution	F = Effective Rainfall[d]	G = [(C x D) - E - F]: Net Irrigation Amount
Period	(in)	RDI %	(in)	(in)	(in)
Jly 8-14	1.24	0.5	0.2	0	0.42
Jly 15-21	1.17	0.5	0.2	0	0.38
Jly 22-28	1.15	0.5	0.2	0	0.38
Jly 29 to Aug 4	1.14	0.5	0.2	0	0.37
Aug 5-11	1.11	0.5	0.2	0	0.35
Aug 12-18	1.06	0.5	0.2	0	0.33
Aug 19-25	1.02	0.5	0.2	0	0.31
Aug 26 to Sept 1	0.98	0.5	0.2	0	0.29
Sept 2-8	0.93	0.5	0.2	0	0.27
Sept 9-15	0.83	0.5	0.2	0	0.22
Sept 16-22	0.80	0.5	0.2	0	0.20
Sept 23-29	0.72	0.5	0.2	0	0.16
Sept 30 to Oct 6	0.66	1		0	0.66
Oct 7-13	0.60	1		0	0.60
Oct 14-20	0.53	1		0	0.53
Oct 21-27	0.45	1		0	0.45
Oct 28 to Nov 3	0.37	1		0.32	0.05
Total	14.75		2.40		5.96

Determining the Net Weekly Vine Irrigation Volume

- Irrigation Uniformity
  - Under deficit irrigation, Irrigation Uniformity = Emission Uniformity (i.e. there are no deep percolation losses)

- Irrigation system application rate
- Vine spacing

Date	G = [(C x D) - E - F]: Net Irrigation Amount	H = Emission Uniformity[e]	I = G/H:Gross Irrigation Amount	J = Vine Spacing[f]	K = (I x J x .623): Gallons per Vine/ Period	L = Average Application Rate	M = (K/L): Hours of PREDICTED Irrigation Time
Period	(in)	(%)	(in)	(sq feet)	(gal/week)	(gph/vine)	(hours)
Jly 8-14	0.42	92	0.45	77	21.8	0.96	22.7
Jly 15-21	0.38	92	0.42	77	20.1	0.96	20.9
Jly 22-28	0.38	92	0.41	77	19.6	0.96	20.4
Jly 29 to Aug 4	0.37	92	0.40	77	19.3	0.96	20.1
Aug 5-11	0.35	92	0.38	77	18.4	0.96	19.2
Aug 12-18	0.33	92	0.36	77	17.2	0.96	17.9
Aug 19-25	0.31	92	0.33	77	16.1	0.96	16.7
Aug 26 to Sept 1	0.29	92	0.32	77	15.2	0.96	15.9
Sept 2-8	0.27	92	0.29	77	13.8	0.96	14.4
Sept 9-15	0.22	92	0.24	77	11.3	0.96	11.8
Sept 16-22	0.20	92	0.22	77	10.3	0.96	10.8
Sept 23-29	0.16	92	0.17	77	8.3	0.96	8.6
Sept 30 to Oct 6	0.66	92	0.72	77	34.5	0.96	36.0
Oct 7-13	0.60	92	0.65	77	31.3	0.96	32.6
Oct 14-20	0.53	92	0.58	77	27.6	0.96	28.8
Oct 21-27	0.45	92	0.49	77	23.4	0.96	24.4
Oct 28 to Nov 3	0.05	92	0.05	77	2.4	0.96	2.5
Total	5.96		6.47				
	Gallons per vine applied though harvest =				191.3		
			Hours of irrigation time through harvest =				199.3

Full Potential and Deficit Water Use and sources