4/19/07

AN ESTIMATE OF CROP WATER REQUIREMENTS IN THE ANTELOPE VALLEY

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ACKNOWLEDGEMENTS

The bulk of the analysis and data collection was performed by Grant Poole, University of California Cooperative Extension (UCCE) Farm Advisor for Los Angeles County from 2001 through 2006 and Blake Sanden, (UCCE) Farm Advisor for Kern County. Steve Orloff, (UCCE) Farm Advisor for Los Angeles County from 1984 to 1992 and presently the (UCCE) County Director and Farm Advisor for Siskiyou County and Blaine Hansen, Irrigation and Drainage Specialist, University of California at Davis provided insightful and helpful suggestions. Tim Hays, Agricultural Consultant and California Licensed Pest Control Advisor also provided significant inputs. This document and its contents were also discussed with growers producing alfalfa, onions, carrots, grain, sudan and other crops. All individuals who reviewed and provided information and suggestions for this document have significant past and current knowledge of the growing conditions and irrigation requirements in Antelope Valley.

DISCUSSION

The irrigation challenges in Antelope Valley are perhaps unique to all of California because solid set irrigation is one of the most popular types, sandy soils are common, and heavy winds prevail.

The calculations below are the best estimates of average crop water usage assuming all irrigations perform as anticipated with no unexpected problems such as equipment failure, the irrigation sets finishing when expected, etc. and no severe weather events such as excessive heat, high winds, etc. Otherwise, more water is required than these estimates represent. These calculations account for planting dates, harvesting dates, and end-of-season dates.

Historical data from Palmdale and Littlerock were used to estimate the amount of reference or “normal year” potential evapotranspiration (ETo) for Antelope Valley as shown in Table 2. ETo data from the CIMIS weather station in Victorville, CA is very similar to the Palmdale and Littlerock data and the Victorville is shown in Table 1 for comparison.. Climatic conditions largely

determine evapotranspiration and observations over many years by local Farm Advisors have indicated that Victorville data closely represent the climatic conditions in Antelope Valley.

Once the reference evapotranspiration ETo is known, the evapotranspiration for each crop (ETc) can be determined by

$$ETc = Kc\ (ETo)$$

where Kc is the crop coefficient. The crop coefficient varies with the crop, its stage of development, and the frequency of irrigation at less than full crop cover. Since these coefficients are practically independent of location, they can be used over a wide area.

ETc is the amount of water that must be supplied to the plant for proper growth, sometimes called net water requirements. Unfortunately, irrigation systems are not perfect and some additional water losses occur in the form of deep percolation, ponding, runoff, etc. The total amount of water that must be applied to the crop, often called gross water requirements, is calculated by

$$\text{Gross Water Requirement} = \text{Net Water Requirement} / (\text{Irrigation System Efficiency})$$

These irrigation system efficiencies have been developed over the years from field studies by University of California researchers and the Natural Resources Conservation Service (NRCS). With rare exceptions, irrigation system efficiencies for each particular type of irrigation method have not varied significantly from 1970 to the present. However, because the cost of irrigation water was less during these earlier periods, the amount of water wasted during these periods was greater than today. Some growers in the Antelope Valley area estimate their total water usage per acre was 25% greater during these earlier periods.

The following tables represent the "normal year" potential evapotranspiration, ETo , Crop Coefficients, and Evapotranspiration Requirements for various crops currently and historically grown in the Lancaster, CA area. Note that a heavy rainfall winter, which produces "effective rainfall," that is, rainfall that soaks into the soil and is not dissipated by evaporation, runoff, etc. may slightly reduce these requirements.

Table 4 lists the water requirements to reduce wind erosion damage in onion and carrot crops and the water applied when no crop is growing to facilitate field preparation and other cultural practices. These water requirements are not included in the crop evaporation estimates. Table 4 also shows the total crop water requirements in Antelope Valley.

Table 1. Plant evapotranspiration data for Jan. to December 2003, collected from Victorville, CA CIMIS weather station number 117, to be used as an estimate for ET near Palmdale, CA.

January	ETo(in)	February	ETo(in)	March	ETo(in)	April	ETo(in)	May	ETo(in)	June	ETo(in)	July	ETo(in)	August	ETo(in)	September	ETo(in)	October	ETo(in)	November	ETo(in)	December	ETo	January	ETo
1/1	0.07	2/1	0.13	3/1	0.12	4/1	0.24	5/1	0.21	6/1	0.29	7/1	0.34	8/1	0.22	9/1	0.26	10/1	0.21	11/1	0.07	12/1	0.1	1/1	0.09
1/2	0.07	2/2	0.11	3/2	0.13	4/2	0.18	5/2	0.21	6/2	0.31	7/2	0.32	8/2	0.27	9/2	0.16	10/2	0.2	11/2	0.08	12/2	0.07	1/2	0.08
1/3	0.06	2/3	0.09	3/3	0.09	4/3	0.17	5/3	0.16	6/3	0.32	7/3	0.38	8/3	0.28	9/3	0.17	10/3	0.16	11/3	0.08	12/3	0.08	1/3	0.08
1/4	0.07	2/4	0.11	3/4	0.10	4/4	0.18	5/4	0.20	6/4	0.31	7/4	0.31	8/4	0.32	9/4	0.23	10/4	0.16	11/4	0.08	12/4	0.07	1/4	0.06
1/5	0.08	2/5	0.10	3/5	0.12	4/5	0.19	5/5	0.22	6/5	0.29	7/5	0.32	8/5	0.32	9/5	0.22	10/5	0.17	11/5	0.09	12/5	0.07	1/5	0.06
1/6	0.13	2/6	0.11	3/6	0.15	4/6	0.19	5/6	0.22	6/6	0.30	7/6	0.32	8/6	0.32	9/6	0.25	10/6	0.17	11/6	0.08	12/6	0.11	1/6	0.05
1/7	0.14	2/7	0.11	3/7	0.14	4/7	0.20	5/7	0.21	6/7	0.30	7/7	0.31	8/7	0.31	9/7	0.27	10/7	0.17	11/7	0.1	12/7	0.06	1/7	0.08
1/8	0.06	2/8	0.08	3/8	0.15	4/8	0.23	5/8	0.14	6/8	0.31	7/8	0.3	8/8	0.33	9/8	0.26	10/8	0.17	11/8	0.07	12/8	0.07	1/8	0.07
1/9	0.07	2/9	0.09	3/9	0.16	4/9	0.22	5/9	0.25	6/9	0.31	7/9	0.32	8/9	0.32	9/9	0.25	10/9	0.19	11/9	0.1	12/9	0.08	1/9	0.06
1/10	0.03	2/10	0.12	3/10	0.16	4/10	0.24	5/10	0.21	6/10	0.30	7/10	0.31	8/10	0.32	9/10	0.21	10/10	0.16	11/10	0.09	12/10	0.08	1/10	0.07
1/11	0.06	2/11	0.02	3/11	0.16	4/11	0.21	5/11	0.25	6/11	0.28	7/11	0.32	8/11	0.24	9/11	0.22	10/11	0.15	11/11	0.09	12/11	0.06	1/11	0.07
1/12	0.07	2/12	0.00	3/12	0.16	4/12	0.23	5/12	0.28	6/12	0.27	7/12	0.31	8/12	0.31	9/12	0.23	10/12	0.17	11/12	0	12/12	0.05	1/12	0.07
1/13	0.07	2/13	0.01	3/13	0.19	4/13	0.19	5/13	0.22	6/13	0.28	7/13	0.32	8/13	0.27	9/13	0.23	10/13	0.16	11/13	0.08	12/13	0.04	1/13	0.07
1/14	0.06	2/14	0.08	3/14	0.17	4/14	0.06	5/14	0.18	6/14	0.30	7/14	0.33	8/14	0.28	9/14	0.27	10/14	0.19	11/14	0.08	12/14	0.06	1/14	0.08
1/15	0.08	2/15	0.11	3/15	0.04	4/15	0.18	5/15	0.25	6/15	0.32	7/15	0.33	8/15	0.3	9/15	0.27	10/15	0.2	11/15	0.06	12/15	0.06	1/15	0.07
1/16	0.08	2/16	0.11	3/16	0.10	4/16	0.20	5/16	0.28	6/16	0.29	7/16	0.25	8/16	0.29	9/16	0.27	10/16	0.15	11/16	0.06	12/16	0.08	1/16	0.07
1/17	0.09	2/17	0.08	3/17	0.18	4/17	0.18	5/17	0.27	6/17	0.30	7/17	0.21	8/17	0.28	9/17	0.25	10/17	0.15	11/17	0.07	12/17	0.05	1/17	0.08

1/18	0.08	2/18	0.10	3/18	0.18	4/18	0.16	5/18	0.26	6/18	0.32	7/18	0.28	8/18	0.3	9/18	0.21	10/18	0.16	11/18	0.08	12/18	0.06	1/18	0.08
January	**ETo(in)**	**February**	**ETo(in)**	**March**	**ETo(in)**	**April**	**ETo(in)**	**May**	**ETo(in)**	**June**	**ETo(in)**	**July**	**ETo(in)**	**August**	**ETo(in)**	**September**	**ETo(in)**	**October**	**ETo(in)**	**November**	**ETo(in)**	**December**	**ETo**	**January**	**ETo**
1/19	0.08	2/19	0.12	3/19	0.15	4/19	0.19	5/19	0.25	6/19	0.29	7/19	0.29	8/19	0.32	9/19	0.21	10/19	0.15	11/19	0.07	12/19	0.06	1/19	0.07
1/20	0.10	2/20	0.11	3/20	0.18	4/20	0.20	5/20	0.27	6/20	0.25	7/20	0.3	8/20	0.24	9/20	0.22	10/20	0.15	11/20	0.12	12/20	0.07	1/20	0.07
1/21	0.10	2/21	0.13	3/21	0.16	4/21	0.18	5/21	0.28	6/21	0.26	7/21	0.31	8/21	0.22	9/21	0.22	10/21	0.15	11/21	0.11	12/21	0.07	1/21	0.09
1/22	0.07	2/22	0.15	3/22	0.19	4/22	0.15	5/22	0.31	6/22	0.27	7/22	0.26	8/22	0.29	9/22	0.21	10/22	0.17	11/22	0.09	12/22	0.07	1/22	0.1
1/23	0.06	2/23	0.09	3/23	0.19	4/23	0.20	5/23	0.31	6/23	0.27	7/23	0.29	8/23	0.28	9/23	0.23	10/23	0.14	11/23	0.07	12/23	0.03	1/23	0.08
1/24	0.09	2/24	0.11	3/24	0.16	4/24	0.22	5/24	0.30	6/24	0.26	7/24	0.32	8/24	0.23	9/24	0.17	10/24	0.14	11/24	0.04	12/24	0.06	1/24	0.07
1/25	0.10	2/25	0.02	3/25	0.18	4/25	0.21	5/25	0.29	6/25	0.31	7/25	0.31	8/25	0.25	9/25	0.2	10/25	0.16	11/25	0.11	12/25	0.06	1/25	0.08
1/26	0.10	2/26	0.07	3/26	0.23	4/26	0.23	5/26	0.27	6/26	0.28	7/26	0.22	8/26	0.2	9/26	0.2	10/26	0.16	11/26	0.07	12/26	0.09	1/26	0.08
1/27	0.10	2/27	0.11	3/27	0.19	4/27	0.26	5/27	0.30	6/27	0.30	7/27	0.28	8/27	0.22	9/27	0.2	10/27	0.14	11/27	0.09	12/27	0.05	1/27	0.1
1/28	0.08	2/28	0.12	3/28	0.23	4/28	0.23	5/28	0.31	6/28	0.32	7/28	0.28	8/28	0.24	9/28	0.23	10/28	0.13	11/28	0.05	12/28	0.05	1/28	0.08
1/29	0.09			3/29	0.23	4/29	0.22	5/29	0.32	6/29	0.34	7/29	0.19	8/29	0.27	9/29	0.22	10/29	0.17	11/29	0.06	12/29	0.06	1/29	0.08
1/30	0.10			3/30	0.22	4/30	0.21	5/30	0.31	6/30	0.35	7/30	0.24	8/30	0.24	9/30	0.22	10/30	0.14	11/30	0.07	12/30	0.07	1/30	0.13
1/31	0.11			3/31	0.23			5/31	0.30			7/31	0.24	8/31	0.29			10/31	0.11			12/31	0.06	1/31	0.09
January	2.55	February	2.59	March	5.04	April	5.95	May	7.84	June	8.90	July	9.11	August	8.57	September	6.76	October	5.00	November	2.31	December	2.05	January	2.41
Daily Ave.	0.08	Daily Ave.	0.09	Daily Ave.	0.16	Daily Ave.	0.20	Daily Ave.	0.25	Daily Ave.	0.30	Daily Ave.	0.29	Daily Ave.	0.28	Daily Ave.	0.23	Daily Ave.	0.16	Daily Ave.	0.08	Daily Ave.	0.07	Daily Ave.	0.08

TABLE 2. CROP COEFFICIENTS (Kc) IN THE HIGH DESERT[1,5]

Date	Pasture ETo	Alfalfa[2]	Silage 4/1-8/25	Silage 6/15-10/15	Sudan[3]	Cereal Forage	Sugar Beets	Peas/ Beans	Onions	Carrots	Carrots	Potatoes	Deciduous[4] Fruit Trees	Melons	Sod
1/1	0.87	0.40				0.30									1.00
1/15	1.07	0.40				0.30									1.00
2/1	1.19	0.40				0.30				0.31					1.00
2/15	1.45	1.00				0.41				0.31					1.00
3/1	2.08	1.15				0.66			0.30	0.31		0.55	0.25		1.00
3/15	2.54	1.15				0.92	0.15	0.14	0.30	0.55		0.61	0.54	0.18	1.00
4/1	2.80	1.05	0.14			1.00	0.15	0.14	0.30	0.82		0.88	0.60	0.18	1.00
4/15	3.20	1.05	0.18			1.00	0.37	0.46	0.53	1.03		1.16	0.66	0.34	1.00
5/1	3.60	1.05	0.31			1.15	0.61	1.11	0.83	1.11	0.31	1.21	0.72	0.72	1.00
5/15	4.01	1.05	0.94			1.10	0.88	1.15	1.14	1.13	0.31	1.19	0.79	1.11	1.00
6/1	4.25	1.05	1.14	0.14		0.78	1.11	1.15	1.14	1.05	0.55	0.87	0.84	1.11	1.00
6/15	4.52	1.05	1.18	0.25	0.30		1.11	0.93	1.14	1.00	0.82	0.55	0.86	1.11	1.00
7/1	4.85	1.05	1.18	0.56	0.85		1.11	0.49	1.04		1.03		0.92	0.78	1.00
7/15	4.83	1.05	1.15	1.00	1.10		1.07		0.92		1.11		0.94	0.29	1.00
8/1	4.50	1.05	1.06	1.15	0.85		1.04		0.80		1.13		0.94		1.00
8/15	4.28	1.05	0.98	1.20	1.10		1.00		0.68		1.05		0.94		1.00
9/1	3.75	1.05		1.20	0.85		0.97						0.94		1.00
9/15	3.27	1.05		1.06	1.00								0.91		1.00
10/1	2.90	1.05			1.10								0.85		1.00
10/15	2.48	1.05			1.10								0.79		1.00
11/1	1.70	1.05											0.70		1.00
11/15	1.07	0.40													1.00
12/1	0.97	0.40													1.00
12/15	0.90	0.40													1.00
Total	67.08														

TABLE 3. CROP EVAPOTRANSPIRATION (ET_C IN INCHES) IN ANTELOPE VALLEY

Date	Pasture/ Sod	Alfalfa	Silage 4/1-8/25	Silage 6/15-10/15	Sudan	Cereal Forage	Sugar Beets	Peas/ Beans	Onions	Carrots	Carrots	Potatoes	Deciduous Fruit Trees	Melons
1/1	0.87	0.35				0.26								
1/15	1.07	0.43				0.32								
2/1	1.19	0.48				0.36				0.37				
2/15	1.45	1.45				0.60				0.45				
3/1	2.08	2.39				1.37			0.62	0.64		1.14	0.52	
3/15	2.54	2.92				2.34	0.38	0.36	0.76	1.40		1.55	1.37	0.46
4/1	2.80	2.94	0.39			2.80	0.42	0.39	0.84	2.30		2.46	1.68	0.50
4/15	3.20	3.36	0.56			3.20	1.18	1.47	1.70	3.30		3.71	2.11	1.09
5/1	3.60	3.78	1.13			4.14	2.20	4.00	2.99	4.00	1.12	4.36	2.59	2.59
5/15	4.01	4.21	3.76			4.41	3.53	4.61	4.57	4.53	1.24	4.77	3.17	4.45
6/1	4.25	4.46	4.83	0.58		3.32	4.72	4.89	4.85	4.46	2.34	3.70	3.57	4.72
6/15	4.52	4.75	5.33	1.13	1.36		5.02	4.20	5.15	4.52	3.71	2.49	3.89	5.02
7/1	4.85	5.09	5.72	2.73	4.12		5.38	2.38	5.04		5.00		4.46	3.78
7/15	4.83	5.07	5.55	4.83	5.31		5.17		4.44		5.36		4.54	1.40
8/1	4.50	4.73	4.78	5.18	3.83		4.68		3.60		5.09		4.23	
8/15	4.28	4.49	4.17	5.14	4.71		4.28		2.91		4.49		4.02	
9/1	3.75	3.94		4.50	3.19		3.64				0.00		3.53	
9/15	3.27	3.43		3.47	3.27.						0.00		2.98	
10/1	2.90	3.05			3.19								2.47	
10/15	2.48	2.60			2.73.								1.96	
11/1	1.70	1.79											1.19	
11/15	1.07	0.43												
12/1	0.97	0.39												
12/15	0.90	0.36												
Total Inches Of Net Water Use	67.08	66.89	36.22	27.56	31.71	23.12	40.60	22.30	37.47	25.97	28.35	24.18	48.28	24.01

TABLE 4. GROSS AND NET CROP WATER REQUIREMENTS (IN INCHES) IN ANTELOPE VALLEY

	Pasture/ Sod	Alfalfa	Silage 4/1-8/25	Silage 6/15-10/15	Sudan	Cereal Forage	Sugar Beets	Peas/ Beans	Onions	Carrots	Carrots	Potatoes	Deciduous Fruit Trees	Melons
Net Evapo-transpiration Water Requirement	67.08	66.89	36.22	27.56	31.71	23.12	40.60	22.30	37.47	25.97	28.35	24.18	48.28	24.01
Net Soil Erosion Water Requirement									3.54	4.46	6.08			
Net Non-Growing Water Requirement[10]	0.00	2.00	4.00	4.00	4.00	4.00	4.00	4.00	6.00[7]	6.50[8]	6.50[8]	4.00	0.00	4.00
Total Net Water Requirement	67.08	68.89	40.22	31.56	35.71	27.12	44.60	26.30	47.01	36.93	40.93	30.18	48.28	28.01
Irrigation Efficiency	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%[9]	75%
Gross Water Requirement														
Inches	89.44	91.85	53.63	42.08	46.80	36.16	59.47	35.07	62.68	49.24	54.57	40.24	64.37	37.35
Acre Feet	7.45	7.65	4.47	3.51	3.90	3.01	4.96	2.92	5.22	4.10	4.55	3.35	5.36	3.11

References

1) Crop Coefficients were adapted from two references: Hansen, B.R., Shwannkl, L., and Fulton, A. "Scheduling Irrigations: When and How Much Water to Apply," Water Management Series Publication Number 3396, Dept. of Land, Air & Water Resources, University of California, Davis, California and Pruitt, W. O., Fereres, E., Kelta, K., and Snyder, R. L., "Reference Evapotransppiration (ETo) for California," UC Bull. 1922
2) Kc of 1.05 takes into account reduced ET during the cuttings throughout the season. Since some alfalfa varieties go dormant during major portions of December and January and some rainfall may occur during this period, perhaps about 3 inches of applied water need not be applied during this period.
3) Sudan was cut on 7/1, 8/16, and 10/16. ET was reduced for 1 to 2 weeks after cutting.
4) Deciduous Fruit Tree Crop Coefficients were adapted from Orloff, S. B. "Deciduous Orchard Water Use, clean cultivated trees for a normal year in Littlerock, Local Extension Publication
5) Pasture ETo and Forage Crop Coefficients were drafted by B. L. Sanden, Kern County Farm Advisor, 2002, and modified by G. J. Poole, Los Angeles County Farm Advisor, 2004
6) Assumes a 5-year life of an alfalfa stand and includes the water requirement for pre-irrigation before field preparation and planting.
7) Water is required for pre-irrigation before field preparation, fumigation and "water capping" after fumigation.
8) Water is required for pre-irrigation before field preparation, fumigation and "water capping" after fumigation.
9) From 1991 on, drip irrigation in orchards became popular and the irrigation efficiency increased to 90%.
10) These water requirements are not included elsewhere.