

TABLE OF CONTENTS

TABLE OF CONTENTS	1
ESTIMATE CURRENT AGRICULTURAL IRRIGATION WATER REQUIREMENTS	2
EXPLANATION OF DISTINCT APPROACHES	2
PROCEDURES AND CONCEPTS	2
CROPPING PATTERNS	4
CROP EVAPOTRANSPIRATION	6
Reference Crop Evapotranspiration (ET _o)	6
Crop Coefficients (K _c)	7
Crop Evapotranspiration (ET _c)	11
EFFECTIVE RAINFALL	12
FROST PROTECTION	13
Grapes	14
Strawberries	14
LEACHING REQUIREMENTS	15
IRRIGATION EFFICIENCIES	15
GROSS IRRIGATION WATER REQUIREMENT	17
ESTIMATE PROJECTED IRRIGATION WATER REQUIREMENTS	19
CROPPING PATTERNS	19
IRRIGATION METHODS	20
OTHER PARAMETERS	20
PROJECTED IRRIGATION WATER REQUIREMENT	21
APPENDIX A DWR 113-3 DATA	23
APPENDIX B DETERMINATION OF CROP EVAPOTRANSPIRATION	25
APPENDIX C CURRENT GROSS IRRIGATION WATER REQUIREMENT	28
APPENDIX D PROJECTED GROSS IRRIGATION WATER REQUIREMENT	32
REFERENCES	36

ESTIMATE CURRENT AGRICULTURAL IRRIGATION WATER REQUIREMENTS

EXPLANATION OF DISTINCT APPROACHES

Quantifying regional agricultural water resources can utilize several distinct approaches and methods.

In establishing a *water balance within a basin*, the analysis requires quantifying inflows and outflows of the basin boundaries. There are surface inflows and outflows, subsurface inflows and outflows, changes in water storage within the boundaries, precipitation, and consumptive use (Burt et al. 1997). Applied irrigation water is commonly recycled within the basin and is available for future use (i.e., water which deep percolates on one farm can be pumped by another farm within the basin). Furthermore, water which leaves one basin can be utilized by a downstream user. Quantifying basin agricultural water demands from a water balance perspective requires quantifying only irrigation water which is consumptively used (i.e., is considered irrecoverable) or leaves the basin boundaries (i.e., via surface runoff or subsurface flows). Quantifying the parameters necessary for water balance analysis is challenging and is beyond the scope of this phase of the master water plan.

Another approach examines the quantity of applied irrigation water. This allows planners to partition water utilized by various entities and understand the various uses of a region's water resources. Since a portion of the applied irrigation water can be used by another user elsewhere, water applied for irrigation water is not "lost" to the system. This analysis will examine the current and projected applied irrigation water throughout the county.

PROCEDURES AND CONCEPTS

Estimating the gross irrigation water requirement can be characterized by the following general formula (Burt, 1997):

$$\text{Gross Irrigation Water Requirement} = \frac{\text{Crop ET} + \text{Cultural Practices} - \text{Contribution from rain or shallow water table}}{(1 - \text{Leaching Requirement}) \times \frac{\text{Irrigation Efficiency}}{100}}$$

In San Luis Obispo County, the equation is modified slightly according to local data gathered for the MWP. The basic formula to calculate the gross irrigation water requirement for local conditions can be modified as follows:

$$\text{Gross Irrigation Water Requirement} = \frac{\text{Crop ET} - \text{Contrib. from rain or shallow water table}}{(1 - \text{Leaching Requirement}) \times \frac{\text{Irrigation Efficiency}}{100}} + \text{Climate Control}$$

This analysis must be completed for each crop group, acreage, and weather pattern to calculate total gross irrigation water requirement by water planning area

While the formula is fairly straight forward, several general issues should be considered:

- Diverse weather conditions and micro-climates within the county affect plant water use. A field with the same crop can use a different amount of water than another field with the same crop in close proximity.
- Several different commodities are grown on the Central Coast. Either an analysis needs to be completed for each individual crop, or the crops need to be grouped together in similar water use/cropping categories. There are advantages and disadvantages to each approach.
- Irrigation practices affect both irrigation efficiencies and evapotranspiration of a crop, thus affecting both the numerator and denominator of the fundamental equation. Specific irrigation hardware and management practices vary widely throughout the county.
- Published data on water use may not be transferable to another location due to different irrigation practices, planting dates, season lengths, and cultural practices. This especially affects calculation of irrigation water requirements on vegetables.
- Irrigation efficiencies are extremely difficult to measure directly and are dependent on irrigation hardware and the management on-farm.
- Cropping acreage organized by crop and location is difficult to obtain. Aerial photos indicate crop and location, but they won't reflect changes in cropping patterns or multiple rotations. Aerial

photos do not reflect the recent proliferation in grape acreage. Annual crop reports by the San Luis Obispo County Agricultural Commissioner reflect multiple rotations and variable cropping patterns, but they do not indicate location. In addition, annual crop reports do not reflect non-bearing vineyard acreage. The 1995/1996 Department of Water Resources Land Use Survey will supply cropping acreage and location, but it will have to be significantly manipulated before it can be used for an analysis by basin. Pesticide Use Reports offer the same information but also must be manipulated significantly to be in useable form.

- Crop rotations and multiple cropping patterns in San Luis Obispo County change from year to year and affect acreage data.
- Many gaps exist in the data, therefore assumptions must be made based on field observations of agricultural professionals in the county.

Estimating the gross irrigation water requirement will utilize a combination of information—both published data and accepted methods, along with information gathered from extension agents, consultants, growers, and irrigation specialists.

CROPPING PATTERNS

Annual crop reports published by the Agricultural Commissioner's office provide fundamental data regarding cropping patterns in the county (Table a). This information is also useful in understanding the trends in cropping patterns and the significant crops in each major group.

Table a. Total agricultural cropping acreage for San Luis Obispo County.

Crop	Acreage 1					
	1991	1992	1993	1994	1995	1996
Fruit/Nut 2						
Almonds	2,799	2,400	2,400	2,200	0	0
Apples	565	744	1,206	1,250	1,285	1,441
Avocados	1,165	1,165	1,135	1,135	991	1,000
Bushberries	50	48	34	46	0	0
Grapes	8,100	8,327	8,676	9,080	9,380	9,905
Kiwi	60	0	0	0	0	0
Lemons	882	1,035	1,035	1,035	1,035	1,075
Pistachios	64	87	90	90	120	120
Strawberries	518	805	700	650	530	515
Oranges	150	182	257	262	272	272
Walnuts	2,770	2,890	2,700	2,700	2,700	2,560
Other	406	441	730	730	2,000	2,300
Total Acres	17,529	18,124	18,963	19,178	18,313	19,188
Seed 4						
Barley	605	902	940	610	450	640
Oats	885	573	380	720	580	430
Other	360	530	246	784	537	420
Total Acres	1,850	2,005	1,566	2,114	1,567	1,490
Nursery						
Trees	120	110	115	99	138	102
Flowers	114	428	455	469	530	761
Ornamentals	41	17	21	35	25	46
Transplants	98	150	34	68	52	21
Other	5	42	35	5	4	4
Greenhouse	71	68	97	104	99	101
Total Acres	449	814	757	780	848	1,035
Field Crops 4						
Alfalfa	3,480	3,850	3,700	3,800	3,750	3,600
Barley	28,000	30,000	33,200	34,500	25,000	29,500
Garbanzo	0	1,070	1,125	605	883	1,010
Grain Hay 5	30,000	24,000	18,500	22,200	32,000	27,600
Grain Stubble	90,000	75,000	72,000	77,000	70,000	72,000
Irr. Pasture	5,600	5,600	5,500	5,400	5,250	5,200
Rangeland, dry	1,040,000	1,000,000	1,025,000	1,030,000	1,030,000	1,025,000
Safflower	1,600	6,140	6,400	2,040	4,010	2,250
Wheat	3,865	6,044	10,465	7,900	4,500	8,400
Other	1,600	800	1,500	1,600	1,400	900
Total Acres	1,204,145	1,152,504	1,177,390	1,185,045	1,176,793	1,175,460
Vegetable 3						
Beans, green	771	295	310	276	473	662
Bell Peppers	1,000	955	1,123	1,391	1,075	1,101
Broccoli, fresh	6,197	8,894	8,450	9,224	9,738	9,560
Broccoli, frozen	753	1,058	1,114	1,135	840	542
Brussel Sprouts		52	0	0	0	0
Cabbage	1,340	1,457	807	842	463	625

Carrots	4,244	3,531	2,447	2,897	2,939	0
Cauliflower	2,202	2,078	1,500	2,131	1,726	1,760
Celery	1,313	981	1,261	1,393	1,278	1,022
Oriental	1,399	1,120	1,421	1,009	1,551	1,240
Lettuce, head	8,374	7,664	7,722	7,388	6,438	7,365
Lettuce, leaf	1,738	1,677	1,530	1,359	2,118	2,082
Peas	2,200	1,650	2,900	2,800	3,350	3,636
Spinach	243	276	0	0	249	173
Squash	274	113	479	525	560	590
Tomato	0	0	120	94	98	82
Other	1,400	1,200	1,400	1,300	1,200	3,670
Total Acres	33,448	33,001	32,584	33,764	34,096	34,110
Total Acreage	1,257,421	1,206,448	1,231,260	1,240,881	1,231,617	1,231,283

**Table ab. Estimated irrigated crop groups 1996
(adapted from Table a).**

Crop Group	Acreage
Alfalfa	3,600
Nursery	1,030
Pasture	5,200
Permanent	
Citrus	1,750
Deciduous	3,650
Vegetable	34,600
Vineyard	13,450
Total	63,280

1 Estimated from 1996 crop report and 1997 crop report preliminary data.

2 Includes planted, non-bearing grape acreage.

In San Luis Obispo County, 100% of the nursery and vegetable crops are irrigated. During normal years, most of the field crops are grown on rainfall and are not irrigated. The exceptions are alfalfa and irrigated pasture which are routinely irrigated during normal years. All of the permanent fruit and nut crops are irrigated except almonds, apples, and walnuts (i.e., none of the almonds are irrigated, 10% of the walnuts are irrigated and 5% of the apples are dryland farmed). Table a was adjusted for irrigated acreage, non-bearing grape and permanent acreage, and preliminary data from the 1997 crop reports. Table ab summarizes the total irrigated acreage in the county by crop group.

To divide crop groups by water planning area, local GIS data and pesticide use records were evaluated. Table b summarizes estimates of irrigated cropping acreage by water planning area.

Table b. Estimated cropping acreage by water planning area.

Water Planning Area	Irrigated Acreage (ac)						Total	
	Alfalfa	Nursery	Pasture	Permanent		Veg.		Vineyard
				Citrus	Decid.			
1 North Coast				50		300		350
2 Cayucos				200		400		600
3 Morro Bay		50		450		4,500		5,000
4 SLO/Avila			200	250	250	1,500	1,350	5,550
5 Five Cities		30	600		600	8,000	700	9,930
6 Nipomo Mesa		950		800		17,000	400	19,150
7 Cuyama	600				2,200	2,000	0	4,800
8 Calif. Valley						100		100
9a Salinas	1,500		4,400		200	200	2,500	8,800
9b Creston	500				200		1,500	2,200
9c Shandon	1,000				200	600	7,000	8,800
10 Nacimiento								0
Total	3,600	1,030	5,200	1,750	3,650	34,600	13,450	63,280

Estimated from annual crop report, county GIS records and pesticide use records.

CROP EVAPOTRANSPIRATION

Several UC Cooperative Extension Leaflets describe estimating crop evapotranspiration where:

$$ET_c = ET_o \times K_c$$

Crop evapotranspiration (ET_c) is estimated by multiplying the weather factor (ET_o) with the crop coefficient (K_c).

Reference evapotranspiration (ET_o) represents the approximate theoretical water use of a well watered, cool-seasoned grass, 4 - 6 inches tall, under full cover. Changes in ET_o from one location to the next represent changes in weather patterns and is used to calculate changing crop water use based on changing weather conditions throughout the county.

Crop coefficients (K_c) vary from day to day, depending on many factors, but they are mainly a function of crop growth and development stage. Crop coefficients are specific to the reference crop used.

Reference Crop Evapotranspiration (ET_o)

Table c summarizes reference evapotranspiration data for a variety of locations in San Luis Obispo County. These values represent "normal" year weather conditions and are consistent with historical data from the Department of Water Resources. Weather data was examined for Kern County since it more closely represents the weather in eastern San Luis Obispo County. Each water planning area was assigned a weather set (Table c1).

Table c. Normal year reference evapotranspiration (ETo) for several areas in San Luis Obispo and Kern Counties.

Month	Average ETo (in/mo)							
	Arroyo Grande (AG)	Lost Hills (LH)	Morro Bay (MB)	Paso Robles (PR)	San Luis Obispo (SLO)	San Miguel (SMG)	San Simeon (SS)	Taft (TF)
January	2.0	0.6	2.0	1.6	2.0	1.6	2.0	1.3
February	2.2	1.1	2.2	2.0	2.2	2.0	2.0	1.8
March	3.2	2.6	3.1	3.2	3.2	3.2	2.9	3.1
April	3.8	4.4	3.5	4.3	4.1	4.3	3.5	4.3
May	4.3	7.0	4.3	5.5	4.9	5.3	4.2	6.2
June	4.7	7.7	4.5	6.3	5.3	6.4	4.4	7.3
July	4.3	8.5	4.6	7.3	4.6	7.4	4.6	8.5
August	4.6	7.1	4.6	6.7	5.5	6.8	4.3	7.3
September	3.6	3.6	3.8	5.1	4.4	5.1	3.5	5.4
October	3.2	3.9	3.5	3.7	3.5	3.7	3.1	3.4
November	2.4	0.8	2.1	2.1	2.4	2.1	2.0	1.7
December	1.7	0.4	1.7	1.4	1.7	1.4	1.7	1.0
Total ETo (in)	40.0	49.0	39.9	49.2	43.8	49.3	38.2	51.2

Source: Determining Daily Reference Evapotranspiration (ETo), UC Cooperative Extension Leaflet 21426.

Table c1. Climate group assignment for each water planning area.

Water Planning Area	Assigned Climate Group
1 North Coast	San Simeon
2 Cayucos	San Simeon
3 Morro Bay	Morro Bay
4 San Luis Obispo/Avila	San Luis Obispo
5 Five Cities	Arroyo Grande
6 Nipomo Mesa	Arroyo Grande
7 Cuyama	Taft
8 California Valley	Taft
9a Salinas	Paso Robles
9b Creston	Paso Robles
9c Shandon	Paso Robles
10 Nacimiento	Paso Robles

Crop Coefficients (Kc)

Crops were grouped into several broad categories according to similar cropping patterns, water use, and DWR crop groupings:

- Alfalfa
- Nursery
- Pasture
- Permanent
 - Citrus
 - Deciduous
- Vegetable
- Vineyard

Kc is used to estimate plant water use for a particular plant in a particular region. Crop coefficients vary between crops, growth stages, locations, irrigation management, and cultural practices (DWR, 1992). Several documents were studied and local extension agents were interviewed. For the purpose of estimating yearly ET requirements in San Luis Obispo County, general crop coefficients were adapted using data from DWR 113-3 (Appendix, table d) and using University of California Cooperative Extension bulletins. While these crop coefficients would not be appropriate to use on-farm to schedule irrigations, they do allow for yearly estimations of crop evapotranspiration by weather subset.

ALFALFA

Semi-dormant varieties of alfalfa are grown in San Luis Obispo County (Smith, M. 1997). Crop coefficient for alfalfa are adapted directly from DWR 113-3 (Table KCA).

Table KCA. Assigned crop coefficient (Kc) for alfalfa.

Crop Group	Month	Avg Kc
Alfalfa	January	
	February	
	March	0.9
	April	0.9
	May	0.9
	June	0.9
	July	1.0
	August	1.0
	September	1.1
	October	1.0
	November	
	December	

Source: Adapted from DWR 113-3.

NURSERY

The diversity of nursery crops grown on the central coast complicates crop coefficient assumptions for the group as a whole. The San Luis Obispo County Agricultural Commissioner's Annual Report documents the various nursery commodities grown in San Luis Obispo County: field cut flowers, greenhouse cut flowers, outdoor ornamentals, indoor ornamentals, bedding plants, sod, vegetable transplants, christmas trees and miscellaneous specialty crops. Cut flowers grown in the field dominate the nursery stock acreage (Annual Crop Report, 1996).

Several variable conditions complicate assigning crop coefficients to the entire nursery crop group: variable crops, variations between indoor vs. outdoor conditions, variable canopy, etc.

UC Cooperative Extension in Santa Barbara County documents estimate water use for various ornamental crops grown in Santa Barbara County (Table SB).

Table SB. Estimated average water use by ornamental crops in Santa Barbara County (AF/Acre).

Crop	Average Water Use (AF/Acre)			
	Santa Barbara South Coast	Santa Maria and Lompoc	Santa Ynez	Cuyama
Cut Flowers (field)	1.8	1.8		
Flower Seeds		2.3	2.7	
Greenhouse				
Carnations	2.5			
Mums, pompoms	4.0			
Mums, potted	5.5			
Turfgrass	2.7	2.7	3.5	4.0

Source: Irrigation Water Use for Major Crops Grown in Santa Barbara County, UC Cooperative Extension. 1991.

Water use for cut flowers grown in the field is equivalent to approximately 50% of annual ETo (Table SB). Since most of the nursery acreage is devoted to field cut flowers and lies in the coastal, mild regions of San Luis Obispo County, this value is assigned to the nursery crop group (Table KCN). This value will be the most representative of the majority of nursery crops grown in SLO County.

Table KCN. Assigned crop coefficient for nursery crops.

Crop Group	Month	Kc
Nursery	January	0.5
	February	0.5
	March	0.5
	April	0.5
	May	0.5
	June	0.5
	July	0.5
	August	0.5
	September	0.5
	October	0.5
	November	0.5
	December	0.5

PASTURE

Irrigated pasture in San Luis Obispo County typically comprise of clover, trefoil, and grasses. Crop coefficients for irrigated pasture were adapted directly from DWR 113-3 (Table KCPasture).

Table KCPasture. Assigned crop coefficient for irrigated pasture.

Crop Group	Month	Crop
Pasture	January	
	February	
	March	1.0
	April	1.0
	May	1.0
	June	1.0
	July	1.0
	August	1.0
	September	1.0
	October	1.0
	November	
	December	

Adapted from DWR 113-3.

PERMANENT

The permanent crops grown on the central coast vary widely and are characterized fruit and nut crops. Permanent crops are be divided into two groups: citrus and deciduous. The deciduous subset only transpires for a portion of the year and has a relatively high crop coefficient for most of its growing season (i.e., apples and walnuts). The evergreen subset has full cover and transpire throughout the year with a lower, constant crop coefficient (i.e., citrus and avocados) (Snyder et al., 1989). Water use will also vary between orchards depending on whether there are cover crops or not.

Crop coefficients (Kc) for deciduous was used deciduous crops as published in DWR 113-3 and UC Leaflet 21428 was used for citrus crop coefficient (Table KCPPerm).

Table KCPPerm. Assigned crop coefficient for the permanent crop group using Kc for deciduous orchard.

Crop Group	Month	Citrus Kc	Deciduous
Permanent	January	0.56	
	February	0.56	
	March	0.56	0.6
	April	0.56	0.7
	May	0.56	0.8
	June	0.56	0.9
	July	0.56	1.0
	August	0.56	1.0
	September	0.56	0.9
	October	0.56	0.8
	November	0.56	
	December	0.56	

Deciduous Kc adapted from DWR 113-3; Citrus Kc adapted from "Using Reference Evapotranspiration (ET_o) and Crop Coefficients to Estimate Crop Evapotranspiration (ET_c) for Trees and Vines." UC Leaflet 21428.

VEGETABLE

Several vegetable crops are grown in San Luis Obispo County: beans, peppers, broccoli, cabbage, carrots, cauliflower, celery, lettuce, peas, spinach, squash, and tomatoes. Specific cultural practices vary from crop to crop and from farm to farm. Most vegetables can be grown year round on the Central Coast. Vegetables are started from both seed and transplant. One field may get 2 - 3 vegetable crops per year.

Several issues affect estimating water use by vegetables in San Luis Obispo County:

- Crop diversity
- Various crop rotations
- Variable growing season lengths based on variable planting dates
- Variable season lengths based on seeding or transplant

These factors complicate assigning a single crop coefficient to the vegetable subgroup. Therefore, general trends regarding the primary vegetable crops were examined. Nearly 2/3 of the total vegetable acreage is devoted to broccoli and lettuce (Annual Report 1996). Special attention was given to the typical practices regarding broccoli and lettuce production in San Luis Obispo County.

The following points illustrate pertinent information regarding lettuce and broccoli production (Lacmmlen, 1998):

BROCCOLI

- Can be planted and harvested nearly 12 months out of the year
- Can be started by seed or transplant
 - Winter 130 day crop from seed
 - 90 day crop from transplant
 - Summer 90 day crop from seed
 - 60 day crop from transplant

LETTUCE

- Can be planted mid-January
 - Winter 120 day crop from seed
 - 90 day crop from transplant
 - Summer 90 day crop from seed
 - 60 day crop from transplant

Most vegetable crops have a constant Kc value near 1.0 from 75% or peak ground shading until the end of the season. Vegetable crops may differ slightly in this peak Kc value, but Kc = 1.0 can be used with little loss in accuracy (Snyder and Schulbach, 1992).

Water use comparisons of vegetables regarding time of planting were examined through UC Extension materials, DWR 113-3, and communications with farm advisors. While a fall crop requires more days to harvest, the weather is cooler (i.e., ETo is lower). Since ETo (in/mo) is lower, crop evapotranspiration (ETc in/mo) is also lower. Conversely, a summer crop grows for less days in warmer weather. The information confirmed that *overall* there is relatively little difference in yearly water use depending on planting time. While some vegetables use more water than others, most of the vegetable acreage in San Luis Obispo County is devoted to the relatively medium to lower water use category (DWR 113-3, Annual Crop Report, 1996). Therefore the Kc for late cauliflower from DWR 113-3 was assigned to the vegetable subgroup (Table Kcveg).

Table Kcveg. Assigned crop coefficient for the vegetable group using late cauliflower.

Crop Group	Month	Kc
Vegetable	January	
	February	
	March	
	April	
	May	
	June	
	July	
	August	1.0
	September	1.0
	October	1.0
	November	1.0
	December	1.0

Source: Adapted from DWR 113-3.

VINEYARD

Crop coefficient values for the vineyard category were assigned directly from DWR 113-3 (Table Kcvin).

Table Kcvin. Assigned crop coefficient values for vineyard group.

Crop Group	Month	Crop
Vineyard	January	
	February	
	March	
	April	
	May	0.6
	June	0.7
	July	0.6
	August	0.5
	September	0.3
	October	0.1
	November	
	December	

Adapted from DWR 113-3.

Crop Evapotranspiration (ETc)

Crop Evapotranspiration is estimated according to the following relationship:

Crop Evapotranspiration= Reference Evapotranspiration x Crop Coefficient OR

$$(ETc) = (ETo) \times (Kc)$$

Appendix B completes ETc estimations for each weather subset using ETo (Table c) and Kc (Table Kc) for each crop group. Yearly ETc totals for each water planning area are summarized in Table ETC.

Table ETC. Yearly crop evapotranspiration (ft) for each crop group and water planning area.

Water Planning Area	Total Crop Evapotranspiration (ETc) AF/Acre/Yr						
	Alfalfa	Nursery	Pasture	Permanent		Vegetable	Vineyard
				Citrus	Decid.		
1 North Coast	2.4	1.6	2.5	1.8	2.2	1.2	1.0
2 Cayucos	2.4	1.6	2.5	1.8	2.2	1.2	1.0
3 Morro Bay	2.6	1.7	2.7	1.9	2.3	1.3	1.0
4 SLO/Avila	2.8	1.8	3.0	2.0	2.5	1.5	1.2
5 Five Cities	2.5	1.7	2.6	1.9	2.2	1.3	1.0
6 Nipomo	2.5	1.7	2.6	1.9	2.2	1.3	1.0
7 Cuyama	3.7	2.1	3.8	2.4	3.3	1.6	1.6
8 Cal. Valley	3.7	2.1	3.8	2.4	3.3	1.6	1.6
9a Salinas	3.6	2.0	3.7	2.3	3.3	1.3	1.6
9b Creston	3.4	2.1	3.5	2.3	3.1	1.5	1.4
9c Shandon	3.4	2.1	3.5	2.3	3.1	1.5	1.4
10 Nacimiento	3.4	2.1	3.5	2.3	3.1	1.6	1.5

EFFECTIVE RAINFALL

The amount of rain used by crops, effective precipitation, is influenced by several factors:

- Frequency, intensity, and total amount of rainfall
- Percentage of ground cover, rate of evapotranspiration, and rooting depth of the crop
- Soil water holding capacity, infiltration rate, and moisture at the time of rainfall

Precise calculations of effective rainfall are difficult to determine and vary from one precipitation event to another.

For example:

- A two inch rainfall may be entirely effective if its duration is such that the precipitation rate does not exceed the infiltration rate and the soil is sufficiently dry to store the water.
- The same two inch rainfall on the same crop, with the same soil characteristics may be minimally effective if the rain occurs in a short period of time.
- Given the same inches depleted, a two inch rainfall occurring on a lettuce crop grown in a sandy soil will be less effective than the two inch rainfall occurring on the lettuce crop grown in a clayey soil because of the soil's water holding capacities.
- A two inch rainfall may be more effective (percentage) than a four inch rainfall, but the four inch rain may provide more inches of effective rain.

In San Luis Obispo County, most of the rainfall occurs from November through March. Historical monthly precipitation totals were examined throughout the county (Table slorain). Each water planning area was assigned a rainfall group for the purpose of estimating effective rainfall (Table slorain2).

Table slorain. Historical monthly precipitation in San Luis Obispo County.

	Average Annual Precipitation (in)					
	Atascadero 1	Nacimiento 2	Nipomo Mesa 3	San Luis Obispo 4	San Simeon 5	Shandon 6
Total (in)	23.1	14.6	16.4	21.9	23.0	10.5

- 1 20 year average based on records kept by Atascadero Mutual Water Company.
- 2 Historical average 1951-1991.
- 3 70 year average based on records kept by San Luis Obispo County.
- 4 Historical average from DWR.
- 5 Interpreted from SLO County Map entitled "Average Annual Precipitation".
- 6 50 year historical average based on records kept by San Luis Obispo County.

Table slorain2. Assigned rainfall groups to water planning areas.

Water Planning Area	Assigned Rainfall Group
1 North Coast	San Simeon
2 Cayucos	San Simeon
3 Morro Bay	San Luis Obispo
4 San Luis Obispo/Avila	San Luis Obispo
5 Five Cities	Nipomo
6 Nipomo Mesa	Nipomo
7 Cuyama	Shandon
8 California Valley	Shandon
9a Salinas	Atascadero
9b Creston	Atascadero
9c Shandon	Shandon
10 Nacimiento	Nacimiento

The California Department of Water Resources conducted an extensive three year field study examining the changes in stored soil moisture as a function of rainfall throughout the San Joaquin Valley (DWR, 1989). The percent of total annual rainfall which was considered effective ranged from 25 to 59 percent of total annual rainfall. The study made several assumptions regarding soil type, depth, crop cover, and growing season before making these conclusions.

Ranges of percentage of effective precipitation were applied to crop groups. Higher percentages were assigned to the deeper rooted crops according to their larger rootzone water holding capacity.

Table effrain. Assigned ranges of typical effective precipitation percentages.

Crop Group	Effective Precipitation Range (%) 1	
	Low	High
Alfalfa	40	60
Nursery	30	50
Pasture	40	60
Permanent		
Citrus	40	60
Deciduous	40	60
Vegetable 2	15	25
Vineyard	30	50

- 1 As a percentage of total annual rainfall.
- 2 2x adjustment factor for multiple cropping.

FROST PROTECTION

In San Luis Obispo County, irrigation water applied for frost protection represents an important beneficial use of the total applied irrigation water. Irrigation water is commonly applied for frost protection on

grapes and strawberries. The amount of water used for frost protection varies from season to season depending on the weather, and it varies from farm to farm depending on the system application rate.

Grapes

For vineyards, the frost threat occurs from March to April on the Central Coast. Depending on the dew point, overhead sprinklers typically may operate from 4 - 6 hours per evening for frost protection. The amount of nights the system needs to run for frost protection range from 0 - 15 times per season; the average situation would require the system to operate 10 - 12 nights per year (Bianchi 1998). Table v shows typical ranges of yearly applied water for frost protection on grapes depending on minutes of runtime per season. For the purpose of calculating applied water, 0.5 AF/Ac/Year is utilized for the water applied for frost protection on grapes.

Table v. Range of annual water applied for frost protection on a typical vineyard for a typical year.

Hours/Night	Nights/Year	Applied Water (AF/Ac/Yr)	
		System Flow Rate (gpm/ac)	
		40	50
4	10	0.27	0.34
	11	0.30	0.38
	12	0.33	0.41
5	10	0.34	0.43
	11	0.38	0.47
	12	0.41	0.52
6	10	0.41	0.52
	11	0.45	0.57
	12	0.49	0.62

Strawberries

The critical frost period for strawberries in San Luis Obispo County is from January - March. Sprinklers typically operate from midnight to 8 am for up to 15 nights per season (Loemmlen 1998). The amount of water applied for frost protection on strawberries will vary year to year and farm to farm. Table s1 describes typical range of applied water for frost protection on strawberries. For the purpose of calculating applied water, 0.8 AF/Ac/Year is utilized for the water applied for frost protection on strawberries. (Strawberries are categorized as a fruit/nut crop in the crop report and under the deciduous crop group in terms of annual water use. The 0.8 AF/Ac/Year for frost protection was applied to the deciduous crop group in the Five Cities Water Planning Area.)

Table s1. Estimated range of applied irrigation water for frost protection on strawberries in San Luis Obispo County.

Typical System Operation for Frost Protection		Applied Water AF/acre
hours/night	nights/year	
6	8	0.48
	10	0.60
	12	0.72
8	8	0.64
	10	0.80
	12	0.96
10	8	0.80
	10	1.00
	12	1.20

1 Assumes 0.10 in/hr gross precipitation rate.

LEACHING REQUIREMENTS

The amount of extra irrigation water which needs to be applied to satisfy the leaching requirement for a particular crop depends on the salt tolerance of the crop and the irrigation water quality. Ground water quality in San Luis Obispo County is typically adequate for crop production and does not necessitate additional *irrigation* water applied for leaching since it is typically satisfied by normal rainfall. Chipping et al. 1993 reports that of the wells tested in the Paso Robles Ground Water Basin Study, most of the wells tested in have EC levels < 1.0 dS/m. Given these water qualities and salt tolerances typical with central coast crops, leaching requirements would be satisfied by rainfall. The notable exception is with apples grown in the Cuyama Valley (Bianchi 1998).

For the purpose of calculating applied water, the leaching requirement for all crop groups is assumed to be satisfied by rainfall. In the Cuyama water planning area a leaching requirement of 15% was assigned for the deciduous crop group.

IRRIGATION EFFICIENCIES

Irrigation efficiencies represent the ratio of irrigation water beneficially used vs. total irrigation water applied. Achieving acceptable irrigation efficiencies depends three issues: improving system distribution uniformity (DU), reducing scheduling errors, and decreasing surface losses. These factors involve both hardware and managerial concerns. Actual irrigation efficiencies are difficult to measure and are commonly estimated according to system type, known uniformities, and special practices.

Literature suggests that certain irrigation systems have the potential to be more efficient than others (Table ie). Nevertheless, there are generally large gaps between potential and actual performance of irrigation systems.

Table ie. Estimated irrigation efficiency ranges based on system type.

Irrigation System Type	Estimated Irrigation Efficiency (I.E.)(%)		
	Max. Potential IE— with excellent design and excellent management	Avg. IE— with excellent design and average management	Low IE— with average design and below average management
Surface	85	70	60
Sprinkler	85	75	60
Micro	90	70	60

Burt, C.M. 1997.

Adapted from Martin et al., 1990.

Micro System Type includes micro-sprinkler, drip emitters, and drip tape.

There is little data regarding irrigation system types in San Luis Obispo County. Local farm advisors were contacted regarding the types of irrigation systems used on local crops. Estimates of irrigation systems used on specific crop groups are given (Table irr). The only crop group which uses surface irrigation system is the vegetable group, although much acreage has been converted to drip in the last 10 years.

Table irr. Estimates of current irrigation system types by crop group.

Crop Group	Percentage of Acreage with Irrigation System Type (%) 1		
	Surface	Sprinkler	Micro
Alfalfa	0	100	0
Nursery	0	50	50
Pasture	0	100	0
Permanent	0	25	75
Vegetable	70	0	30
Vineyard	0	0	100

1 Acreage was placed in a particular category according to the system they use most of the season. For example, nearly all vegetable acreage starts with sprinkler irrigation for one irrigation for germination. This acreage is considered to be surface irrigated if the remaining irrigations are completed with furrows.

Irrigation efficiency can also be expressed by the following relationship:

$$\text{Irrigation Efficiency} = \text{Distribution Uniformity} \times (1 - \text{Losses})$$

Whereas, irrigation efficiency is nearly impossible to measure, a system's distribution uniformity can be quantified and measured with an accepted set of field procedures. Therefore, irrigation efficiency may be estimated more closely using information of distribution uniformity.

The Cachuma Resource Conservation District routinely conducts irrigation evaluations in Santa Barbara and San Luis Obispo Counties. These irrigation evaluations quantify the distribution uniformity of a system. These specialists are an excellent resource in describing the actual performances of irrigation systems in the region. The irrigation specialists conducting these evaluations report that uniformities vary widely throughout the region. Average DU's are approximately 70% for all pressurized irrigation systems. While the newer systems generally have higher uniformities, some drip systems which do not have the proper management or design have DU < 70% (Fastenau 1998). Given this information, average irrigation efficiencies will be less than 70% in the County. For the purpose of estimating applied water, irrigation efficiencies were assigned to crop group according to prevalent irrigation system type and knowledge of typical local uniformities (Table wa).

Table wa. Assigned irrigation efficiency averages for each crop group.

Crop Group	Irrigation Efficiency Range (%)	
	Low	High
Alfalfa	60	70
Nursery	60	70
Pasture	60	70
Permanent	60	70
Vegetable	65	75
Vineyard	65	75

GROSS IRRIGATION WATER REQUIREMENT


Appendix C completes the applied water estimates according to crop group and water planning area. Gross irrigation water requirements are summarized in attached Table gwa. The ranges provided in Table gwa does not represent the extremes in gross irrigation water requirements, but it does represent the typical ranges in a normal year given local variations in effective precipitation and irrigation efficiencies.

Table gwa2. Total gross irrigation water requirement by water planning area (AF/Yr).

Water Planning Area	Annual Gross Irrigation Water Requirement (AF/Yr)		
	Low	High	Average
1 North Coast	340	514	427
2 Cayucos	574	910	742
3 Morro Bay	5,659	8,104	6,882
4 SLO/Avila	3,982	5,955	4,969
5 Five Cities	12,391	16,529	14,460
6 Nipomo Mesa	24,434	32,737	28,585
7 Cuyama	6,283	7,728	7,006
8 Calif. Valley	180	221	200
9a Salinas	22,734	31,616	27,175
9b Creston	3,311	4,935	4,123
9c Shandon	18,063	22,638	20,361
10 Nacimiento	0	0	0
Total	97,971	131,888	114,930

**Table gwa Current Gross Irrigation Water Requirement (AF/Ac/Yr) By Crop Group And Water Planning Area
Values Represent Typical Ranges In A Normal Year**

Water Planning Area	Gross Irrigation Water Requirement (AF/Ac/Yr)																				
	Alfalfa			Nursery			Pasture			Permanent						Vegetable			Vineyard		
	Low	High	Avg	Low	High	Avg	Low	High	Avg	Citrus			Deciduous			Low	High	Avg	Low	High	Avg
										Low	High	Avg	Low	High	Avg						
1 North Coast Area	1.9	2.8	2.3	0.9	1.7	1.3	2.0	3.0	2.5	0.9	1.7	1.3	1.5	2.3	1.9	1.0	1.4	1.2	0.5	1.1	0.8
2 Cayucos Area	1.9	2.8	2.3	0.9	1.7	1.3	2.0	3.0	2.5	0.9	1.7	1.3	1.5	2.3	1.9	1.0	1.4	1.2	0.5	1.1	0.8
3 Morro Bay Area	2.1	3.1	2.6	1.1	1.9	1.5	2.2	3.2	2.7	1.1	1.9	1.5	1.7	2.6	2.1	1.1	1.6	1.4	0.6	1.2	0.9
4 SLO/Avila Area	2.5	3.5	3.0	1.3	2.1	1.7	2.7	3.7	3.2	1.4	2.2	1.8	2.0	3.0	2.5	1.3	1.8	1.6	0.8	1.4	1.1
5 Five Cities Area	2.5	3.3	2.9	1.4	2.1	1.7	2.6	3.5	3.0	1.5	2.2	1.8	2.8	3.6	3.2	1.3	1.7	1.5	0.9	1.4	1.2
6 Nipomo Mesa Area	2.5	3.3	2.9	1.4	2.1	1.7	2.6	3.5	3.0	1.5	2.2	1.8	2.0	2.8	2.4	1.3	1.7	1.5	0.9	1.4	1.2
7 Cuyama Area	4.5	5.5	5.0	2.4	3.1	2.8	4.7	5.7	5.2	3.1	4.0	3.6	4.7	5.8	5.3	1.8	2.2	2.0	2.1	2.6	2.3
8 California Valley Area	4.5	5.5	5.0	2.4	3.1	2.8	4.7	5.7	5.2	2.7	3.4	3.0	4.0	4.9	4.5	1.8	2.2	2.0	2.1	2.6	2.3
9a Salinas Area	3.2	4.4	3.8	1.6	2.5	2.0	3.4	4.6	4.0	1.6	2.5	2.1	2.7	3.8	3.2	1.5	2.0	1.7	1.1	1.8	1.5
9b Creston Area	3.2	4.4	3.8	1.6	2.5	2.0	3.4	4.6	4.0	1.6	2.5	2.1	2.7	3.8	3.2	1.5	2.0	1.7	1.1	1.8	1.5
9c Shandon Area	4.1	5.1	4.6	2.3	3.0	2.6	4.3	5.3	4.8	2.5	3.2	2.9	3.6	4.5	4.0	1.8	2.2	2.0	1.8	2.3	2.1
10 Nacimiento Area	3.8	4.8	4.3	2.1	2.8	2.4	4.0	5.0	4.5	2.2	3.0	2.6	3.3	4.3	3.8	1.7	2.2	1.9	1.6	2.2	1.9

 Little or no irrigation acreage of this type in WPA.

ESTIMATE PROJECTED IRRIGATION WATER REQUIREMENTS

Several issues would affect changes in future irrigation water requirements:

- Changes in cropping acreage and type of crop
- Changes in irrigation methods

Projections completed by the Department of Water Resources in the previously completed master water plan that overall agricultural water requirements would decrease. Declining overall acreage, increases in irrigation efficiencies, and shifts to lower water use crops provide the basis for DWR's projections.

CROPPING PATTERNS

Trends in cropping patterns were examined through historical crop reports and previous water use projections completed by the Department of Water Resources. Table b1 summarizes projected crop acreages by water planning area.

Alfalfa acreage has declined significantly over the last decade, but has remained fairly constant over the last 5 years. In the north county, some land previously planted with alfalfa is being converted to grapes. This represents a portion of the changed alfalfa acreage. Local conditions in the North County favor high yielding alfalfa fields, so it is improbable that the alfalfa acreage will disappear completely.

Acreage devoted to nursery crops have increased significantly in the county. While the increase in nursery crops represents a significant economic impact on the county, the acreage is still relatively minor in terms of applied irrigation water requirements. Demands for vegetable transplants, ornamentals, and flowers will drive the amount of acreage devoted to nursery crops in the future. Ideal local climate conditions support future development of nursery crops in the county.

Irrigated pasture has decreased county wide since 1985. This decrease is expected to continue, but due to the infrastructure built around the horse industry in the county, it is unlikely that it will decrease beyond a certain threshold.

Apple acreage has tripled county wide in the last five years with most of the increase in apple plantings occurring in the San Luis Obispo/Avila and Cuyama water planning areas. This exceeds DWR estimates in growth of deciduous acres. This probably represents the most significant trend in the permanent crop group since citrus plantings and strawberry not increased recently. The increase in deciduous orchards have occurred in previously non-irrigated land.

Favorable climate and market conditions have encouraged an overall increase in vegetable acreage. Vegetable acreage has increased by approximately 500 acres over the last 5 years county wide. The trends in the south county suggest that that new vegetable acreage in the South County is replacing previously non-irrigated lands. Increase in vegetable acreage will typically represent a net increase in estimated irrigation water requirements.

The county has seen a significant proliferation in grape acreage in the last five years located primarily in the North County but also in the Edna Valley region. New plantings have exceeded previous projections by the Department of Water Resources. Current irrigation water requirements given in the previous section reflect grape acreage which is planted but not in production. The current planted acreage is expected to be in production in the next three years. Limitations on the availability of rootstock and contracts suggest that new grape plantings will continue but slow.

Table b1. Projected cropping acreage by water planning area.

Water Planning Area	Irrigated Acreage (ac)						Total	
	Alfalfa	Nursery	Pasture	Permanent		Veg.		Vineyard
				Citrus	Decid.			
1 North Coast				50		350	400	
2 Cayucos				200		400	600	
3 Morro Bay		60	200	450		4,500	5,010	
4 SLO/Avila			500	350	300	1,300	1,800	3,950
5 Five Cities		50			650	8,300	1,100	10,600
6 Nipomo Mesa		1,350		900		17,200	400	19,850
7 Cuyama	600				2,500	2,300		5,400
8 Calif. Valley						100		100
9a Salinas	1,300		4,200		300	200	3,800	9,800
9b Creston	400				300		2,300	3,000
9c Shandon	800				300	600	10,000	11,700
10 Nacimientos								0
Total	3,100	1,460	4,900	1,950	4,350	35,250	19,400	70,410

IRRIGATION METHODS

Improvement in irrigation systems and management will significantly affect the permanent, vegetable and vineyard crop groups which represent the greatest portion of the projected irrigated acreage in the County. New vineyard plantings are typically equipped with well designed and well maintained irrigation systems. In addition, decreasing performance in some of the older systems will require retrofitting and new system installation. The proliferation of new grape acreage and conversion of older systems will improve the irrigation efficiency of the vineyard acreage overall. Similar improvements on on-farm irrigation efficiencies for the permanent crop group is also expected.

Improvement of the technology and the affordability of new drip tape make drip conversions on vegetable acreage affordable and cost effective for local farmers. Conversion of vegetable acreage from furrow systems to drip system is expected to continue and will also reduce the projected irrigation water requirement for this crop group.

Table pie reflects the projected irrigation efficiencies by crop group.

Table pie. Projected irrigation efficiencies in SLO County by crop group.

Crop Group	Irrigation Efficiency Range (%)	
	Low	High
Alfalfa	60	70
Nursery	60	70
Pasture	60	70
Permanent	70	80
Vegetable	70	80
Vineyard	70	80

OTHER PARAMETERS

For the purpose of estimating projected irrigation water requirements, crop ET, leaching requirement, and effective precipitation remain the same as the current irrigation water requirement.

PROJECTED IRRIGATION WATER REQUIREMENT

The same procedures were utilized in estimating projected irrigation water requirements. See attached Table pgwa1. The projected values reflect the changes in cropping acreage and irrigation efficiencies.

Table pgwa2. Projected total gross irrigation water requirement by water planning area (AF/Yr).

Water Planning Area	Projected Annual Gross Irrigation Water Requirement (AF/Yr)		
	Low	High	Average
1 North Coast	362	537	450
2 Cayucos	527	821	674
3 Morro Bay	5,289	7,490	6,389
4 SLO/Avila	4,016	6,055	5,036
5 Five Cities	12,227	16,230	14,229
6 Nipomo Mesa	23,857	31,766	27,812
7 Cuyama	6,564	8,028	7,296
8 Calif. Valley	168	205	187
9a Salinas	22,738	31,824	27,281
9b Creston	3,814	5,747	4,781
9c Shandon	21,886	27,187	24,536
10 Nacimiento	0	0	0
Total	101,448	135,891	118,669

Table pgwa1
Projected Gross Irrigation Water Requirement (AF/Ac/Yr) By Crop Group And Water Planning Area
Values Represent Typical Ranges In A Normal Year

Water Planning Area	Gross Irrigation Water Requirement (AF/Ac/Yr)																				
	Alfalfa			Nursery			Pasture			Permanent						Vegetable			Vineyard		
	Low	High	Avg	Low	High	Avg	Low	High	Avg	Citrus			Deciduous			Low	High	Avg	Low	High	Avg
										Low	High	Avg	Low	High	Avg						
1 North Coast Area	1.9	2.8	2.3	0.9	1.7	1.3	2.0	3.0	2.5	0.8	1.5	1.1	1.3	2.0	1.6	0.9	1.3	1.1	0.5	1.1	0.8
2 Cayucos Area	1.9	2.8	2.3	0.9	1.7	1.3	2.0	3.0	2.5	0.8	1.5	1.1	1.3	2.0	1.6	0.9	1.3	1.1	0.5	1.1	0.8
3 Morro Bay Area	2.1	3.1	2.6	1.1	1.9	1.5	2.2	3.2	2.7	1.0	1.6	1.3	1.5	2.2	1.8	1.1	1.5	1.3	0.6	1.2	0.9
4 SLO/Avila Area	2.5	3.5	3.0	1.3	2.1	1.7	2.7	3.7	3.2	1.2	1.9	1.5	1.8	2.6	2.2	1.3	1.7	1.5	0.8	1.4	1.1
5 Five Cities Area	2.5	3.3	2.9	1.4	2.1	1.7	2.6	3.5	3.0	1.3	1.9	1.6	2.6	3.2	2.9	1.2	1.6	1.4	0.9	1.4	1.1
6 Nipomo Mesa Area	2.5	3.3	2.9	1.4	2.1	1.7	2.6	3.5	3.0	1.3	1.9	1.6	1.8	2.4	2.1	1.2	1.6	1.4	0.9	1.4	1.1
7 Cuyama Area	4.5	5.5	5.0	2.4	3.1	2.8	4.7	5.7	5.2	2.7	3.4	3.1	4.1	5.0	4.5	1.7	2.1	1.9	2.0	2.5	2.2
8 California Valley Area	4.5	5.5	5.0	2.4	3.1	2.8	4.7	5.7	5.2	2.3	2.9	2.6	3.5	4.2	3.9	1.7	2.1	1.9	2.0	2.5	2.2
9a Salinas Area	3.2	4.4	3.8	1.6	2.5	2.0	3.4	4.6	4.0	1.4	2.2	1.8	2.4	3.3	2.8	1.4	1.8	1.6	1.1	1.7	1.4
9b Creston Area	3.2	4.4	3.8	1.6	2.5	2.0	3.4	4.6	4.0	1.4	2.2	1.8	2.4	3.3	2.8	1.4	1.8	1.6	1.1	1.7	1.4
9c Shandon Area	4.1	5.1	4.6	2.3	3.0	2.6	4.3	5.3	4.8	2.2	2.8	2.5	3.2	3.9	3.5	1.7	2.1	1.9	1.8	2.2	2.0
10 Nacimiento Area	3.8	4.8	4.3	2.1	2.8	2.4	4.0	5.0	4.5	2.0	2.6	2.3	2.9	3.7	3.3	1.6	2.0	1.8	1.5	2.0	1.8

■ Little or no irrigation acreage of this type in WPA.

APPENDIX A DWR 113-3 DATA

Table d. Crop coefficients for various crops.

Location Central Coast: Coastal Valleys and Plains

Month	Crop Coefficient (Kc)												
	Alfalfa hay	Barley	Bean, dry	Carrot	Early Caul.	Late Caul.	Corn, field	Decid. Orchard	Spring Lett	Summer Lett.	Fall Lett.	Pasture	Tomatoes
Jan	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
Mar	0.9	1.1	0.0	0.0	0.0	0.0	0.0	0.6	1.0	0.0	0.0	1.0	0.0
Apr	0.9	0.7	0.0	0.0	0.0	0.0	0.0	0.7	1.0	0.0	0.0	1.0	0.0
May	0.9	0.8	0.0	0.0	0.0	0.0	0.0	0.8	0.5	1.0	0.0	1.0	0.3
Jun	0.9	0.0	0.5	0.0	0.0	0.0	0.6	0.9	0.0	1.0	0.0	1.0	0.8
Jul	1.0	0.0	1.1	0.5	0.5	0.0	1.2	1.0	0.0	1.0	0.5	1.0	1.1
Aug	1.0	0.0	0.5	0.8	1.0	1.0	1.1	1.0	0.0	0.0	1.0	1.0	1.1
Sept	1.1	0.0	0.0	1.0	1.0	1.0	0.7	0.9	0.0	0.0	1.0	1.0	0.8
Oct	1.0	0.0	0.0	1.1	1.0	1.0	0.0	0.8	0.0	0.0	0.0	1.0	0.0
Nov	0.0	0.1	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.4	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Adapted from Vegetative Water Use in California, Department of Water Resources Bulletin 113-3, 1974.

Location Central Coast: Interior Valleys

Month	Crop Coefficient (Kc)								
	Alfalfa hay	Barley	Beans, dry	Corn, field	Decid. Orchard	Pasture	Sugar Beets	Tomatoes	Vineyard
Jan	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	0.9	1.1	0.0	0.0	0.6	1.0	0.1	0.0	0.0
Apr	0.9	0.7	0.0	0.0	0.7	1.0	0.3	0.0	0.0
May	0.9	0.3	0.0	0.2	0.8	1.0	0.8	0.3	0.6
Jun	0.9	0.0	0.5	0.6	0.9	1.0	1.2	0.8	0.7
Jul	1.0	0.0	1.1	1.2	1.0	1.0	1.2	1.1	0.6
Aug	1.0	0.0	0.6	1.1	1.0	1.0	1.0	1.1	0.5
Sept	1.0	0.0	0.0	0.6	0.9	1.0	0.8	0.8	0.3
Oct	1.0	0.0	0.0	0.0	0.8	1.0	0.6	0.0	0.1
Nov	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dec	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table. ere. Crop ET (ETc) for various crops on Central Coast.

Location Central Coast: Coastal Valleys and Plains

Growing Season Crop Evapotranspiration (in/mo)													
Month	Alfalfa hay	Barley	Bean, dry	Carrot	Early Caul.	Late Caul.	Corn, field	Decid. Orchard	Spring Lett	Summer Lett.	Fall Lett.	Pasture	Tomatoes
Jan		1.7											
Feb		2.8							2.1				
Mar	2.9	3.4						1.8	3.1			3.1	
Apr	3.6	2.6						2.8	3.9			3.9	
May	4.3	3.8						3.9	2.4	4.7		4.7	1.3
Jun	4.6		2.6				3.0	4.4		4.9		4.9	3.8
Jul	5.2		5.8	2.4	2.6		6.4	5.1		5.3	2.6	5.3	6.0
Aug	4.9		2.6	3.8	4.8	4.8	5.1	4.6			4.8	4.8	5.1
Sept	4.0			3.8	3.8	3.8	2.5	3.5			3.8	3.8	3.1
Oct	3.3			3.4	3.2	3.2		2.6				3.2	
Nov		0.3				2.2							
Dec		0.6				1.5							
Total (in)	32.8	15.2	11.0	13.4	14.4	15.5	17.0	28.7	11.5	14.9	11.2	33.7	19.3

Vegetative Water Use in California, Department of Water Resources Bulletin 113-3, 1974.

Location Central Coast: Interior Valleys

Growing Season Crop Evapotranspiration (in/mo)									
Month	Alfalfa hay	Barley	Beans, dry	Corn, field	Decid. Orchard	Pasture	Sugar Beets	Tomatoes	Vineyard
Jan		1.5							
Feb		2.2							
Mar	3	3.5			1.9	3.3	0.4		
Apr	3.8	2.8			3.1	4.3	1.1		
May	5.2	1.5		0.9	4.7	5.7	4.5	1.6	3.4
Jun	5.8		3.3	3.8	5.5	6.2	7.5	4.7	4.4
Jul	6.5		7.3	8.1	6.4	6.7	8	7.6	4.3
Aug	6.2		3.3	6.5	5.8	6.0	6.2	6.4	2.8
Sept	5.0			3.1	4.3	4.8	3.7	3.8	1.2
Oct	3.8				3.0	3.8	2.2		0.3
Nov		0.3							
Dec		0.6							
Total (in)	39.4	12.4	13.9	22.4	34.7	40.8	33.6	24.1	16.4

APPENDIX B DETERMINATION OF CROP EVAPOTRANSPIRATION

Table f1. Crop evapotranspiration (ETc) for various crop groups for Arroyo Grande weather subset.

Table f1. Arroyo Grande

	ETo	Alfalfa		Nursery		Pasture		Citrus		Deciduous		Vegetable		Vineyard	
		Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc
Jan	2.0		0.0	0.5	1.0		0.0	0.56	1.1		0.0		0.0	0.0	0.0
Feb	2.2		0.0	0.5	1.1		0.0	0.56	1.2		0.0		0.0	0.0	0.0
Mar	3.2	0.9	2.9	0.5	1.6	1.0	3.2	0.56	1.8	0.6	1.9		0.0	0.0	0.0
Apr	3.8	0.9	3.4	0.5	1.9	1.0	3.8	0.56	2.1	0.7	2.7		0.0	0.0	0.0
May	4.3	0.9	3.9	0.5	2.2	1.0	4.3	0.56	2.4	0.8	3.4		0.0	0.6	2.6
Jun	4.7	0.9	4.2	0.5	2.4	1.0	4.7	0.56	2.6	0.9	4.2		0.0	0.7	3.3
Jul	4.3	1.0	4.3	0.5	2.2	1.0	4.3	0.56	2.4	1.0	4.3		0.0	0.6	2.6
Aug	4.6	1.0	4.6	0.5	2.3	1.0	4.6	0.56	2.6	1.0	4.6	1.0	4.6	0.5	2.3
Sept	3.6	1.1	4.0	0.5	1.8	1.0	3.6	0.56	2.0	0.9	3.2	1.0	3.6	0.3	1.1
Oct	3.2	1.0	3.2	0.5	1.6	1.0	3.2	0.56	1.8	0.8	2.6	1.0	3.2	0.1	0.3
Nov	2.4		0.0	0.5	1.2		0.0	0.56	1.3		0.0	1.0	2.4		0.0
Dec	1.7		0.0	0.5	0.9		0.0	0.56	1.0		0.0	1.0	1.7		0.0
Total (in)	40.0		30.5		20.0		31.7		22.4		27.0		15.5		12.2
Total (ft)	3.3		2.5		1.7		2.6		1.9		2.2		1.3		1.0

Table f2. Crop evapotranspiration (ETc) for various crop groups for Morro Bay weather subset.

Table f2. Morro Bay

	ETo	Alfalfa		Nursery		Pasture		Citrus		Deciduous		Vegetable		Vineyard	
		Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc
Jan	2.0	0.0	0.0	0.5	1.0	0.0	0.0	0.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Feb	2.2	0.0	0.0	0.5	1.1	0.0	0.0	0.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Mar	3.1	0.9	2.8	0.5	1.6	1.0	3.1	0.6	1.7	0.6	1.9	0.0	0.0	0.0	0.0
Apr	3.5	0.9	3.2	0.5	1.8	1.0	3.5	0.6	2.0	0.7	2.5	0.0	0.0	0.0	0.0
May	4.3	0.9	3.9	0.5	2.2	1.0	4.3	0.6	2.4	0.8	3.4	0.0	0.0	0.6	2.6
Jun	4.5	0.9	4.1	0.5	2.3	1.0	4.5	0.6	2.5	0.9	4.1	0.0	0.0	0.7	3.2
Jul	4.6	1.0	4.6	0.5	2.3	1.0	4.6	0.6	2.6	1.0	4.6	0.0	0.0	0.6	2.8
Aug	4.6	1.0	4.6	0.5	2.3	1.0	4.6	0.6	2.6	1.0	4.6	1.0	4.6	0.5	2.3
Sept	3.8	1.1	4.2	0.5	1.9	1.0	3.8	0.6	2.1	0.9	3.4	1.0	3.8	0.3	1.1
Oct	3.5	1.0	3.5	0.5	1.8	1.0	3.5	0.6	2.0	0.8	2.8	1.0	3.5	0.1	0.4
Nov	2.1	0.0	0.0	0.5	1.1	0.0	0.0	0.6	1.2	0.0	0.0	1.0	2.1	0.0	0.0
Dec	1.7	0.0	0.0	0.5	0.9	0.0	0.0	0.6	1.0	0.0	0.0	1.0	1.7	0.0	0.0
Total (in)	39.9		30.7		20.0		31.9		22.3		27.2		15.7		12.3
Total (ft)	3.3		2.6		1.7		2.7		1.9		2.3		1.3		1.0

Table f3. Crop evapotranspiration (ETc) for various crop groups for Paso Robles weather subset.

	ETo	Alfalfa		Nursery		Pasture		Citrus		Deciduous		Vegetable		Vineyard	
		Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc
Jan	1.6	0.0	0.0	0.5	0.8	0.0	0.0	0.6	0.9	0.0	0.0	0.0	0.0	0.0	0.0

Feb	2.0	0.0	0.0	0.5	1.0	0.0	0.0	0.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Mar	3.2	0.9	2.9	0.5	1.6	1.0	3.2	0.6	1.8	0.6	1.9	0.0	0.0	0.0	0.0
Apr	4.3	0.9	3.9	0.5	2.2	1.0	4.3	0.6	2.4	0.7	3.0	0.0	0.0	0.0	0.0
May	5.5	0.9	5.0	0.5	2.8	1.0	5.5	0.6	3.1	0.8	4.4	0.0	0.0	0.6	3.3
Jun	6.3	0.9	5.7	0.5	3.2	1.0	6.3	0.6	3.5	0.9	5.7	0.0	0.0	0.7	4.4
Jul	7.3	1.0	7.3	0.5	3.7	1.0	7.3	0.6	4.1	1.0	7.3	0.0	0.0	0.6	4.4
Aug	6.7	1.0	6.7	0.5	3.4	1.0	6.7	0.6	3.8	1.0	6.7	1.0	6.7	0.5	3.4
Sept	5.1	1.1	5.6	0.5	2.6	1.0	5.1	0.6	2.9	0.9	4.6	1.0	5.1	0.3	1.5
Oct	3.7	1.0	3.7	0.5	1.9	1.0	3.7	0.6	2.1	0.8	3.0	1.0	3.7	0.1	0.4
Nov	2.1	0.0	0.0	0.5	1.1	0.0	0.0	0.6	1.2	0.0	0.0	1.0	2.1	0.0	0.0
Dec	1.4	0.0	0.0	0.5	0.7	0.0	0.0	0.6	0.8	0.0	0.0	1.0	1.4	0.0	0.0
Total (in)	49.2		40.7		24.6		42.1		27.6		36.6		19.0		17.3
Total (ft)	4.1		3.4		2.1		3.5		2.3		3.0		1.6		1.4

Table f4. Crop evapotranspiration (ETc) for various crop groups for San Luis Obispo weather subset.

	ETo	Alfalfa		Nursery		Pasture		Citrus		Deciduous		Vegetable		Vineyard	
		Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc
Jan	2.0	0.0	0.0	0.5	1.0	0.0	0.0	0.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Feb	2.2	0.0	0.0	0.5	1.1	0.0	0.0	0.6	1.2	0.0	0.0	0.0	0.0	0.0	0.0
Mar	3.2	0.9	2.9	0.5	1.6	1.0	3.2	0.6	1.8	0.6	1.9	0.0	0.0	0.0	0.0
Apr	4.1	0.9	3.7	0.5	2.1	1.0	4.1	0.6	2.3	0.7	2.9	0.0	0.0	0.0	0.0
May	4.9	0.9	4.4	0.5	2.5	1.0	4.9	0.6	2.7	0.8	3.9	0.0	0.0	0.6	2.9
Jun	5.3	0.9	4.8	0.5	2.7	1.0	5.3	0.6	3.0	0.9	4.8	0.0	0.0	0.7	3.7
Jul	4.6	1.0	4.6	0.5	2.3	1.0	4.6	0.6	2.6	1.0	4.6	0.0	0.0	0.6	2.8
Aug	5.5	1.0	5.5	0.5	2.8	1.0	5.5	0.6	3.1	1.0	5.5	1.0	5.5	0.5	2.8
Sept	4.4	1.1	4.8	0.5	2.2	1.0	4.4	0.6	2.5	0.9	4.0	1.0	4.4	0.3	1.3
Oct	3.5	1.0	3.5	0.5	1.8	1.0	3.5	0.6	2.0	0.8	2.8	1.0	3.5	0.1	0.4
Nov	2.4	0.0	0.0	0.5	1.2	0.0	0.0	0.6	1.3	0.0	0.0	1.0	2.4	0.0	0.0
Dec	1.7	0.0	0.0	0.5	0.9	0.0	0.0	0.6	1.0	0.0	0.0	1.0	1.7	0.0	0.0
Total (in)	43.8		34.2		21.9		35.5		24.5		30.3		17.5		13.8
Total (ft)	3.7		2.8		1.8		3.0		2.0		2.5		1.5		1.2

Table f5. Crop evapotranspiration (ETc) for various crop groups for San Simeon weather subset.

	ETo	Alfalfa		Nursery		Pasture		Citrus		Deciduous		Vegetable		Vineyard	
		Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc
Jan	2.0	0.0	0.0	0.5	1.0	0.0	0.0	0.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Feb	2.0	0.0	0.0	0.5	1.0	0.0	0.0	0.6	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Mar	2.9	0.9	2.6	0.5	1.5	1.0	2.9	0.6	1.6	0.6	1.7	0.0	0.0	0.0	0.0
Apr	3.5	0.9	3.2	0.5	1.8	1.0	3.5	0.6	2.0	0.7	2.5	0.0	0.0	0.0	0.0
May	4.2	0.9	3.8	0.5	2.1	1.0	4.2	0.6	2.4	0.8	3.4	0.0	0.0	0.6	2.5
Jun	4.4	0.9	4.0	0.5	2.2	1.0	4.4	0.6	2.5	0.9	4.0	0.0	0.0	0.7	3.1
Jul	4.6	1.0	4.6	0.5	2.3	1.0	4.6	0.6	2.6	1.0	4.6	0.0	0.0	0.6	2.8
Aug	4.3	1.0	4.3	0.5	2.2	1.0	4.3	0.6	2.4	1.0	4.3	1.0	4.3	0.5	2.2
Sept	3.5	1.1	3.9	0.5	1.8	1.0	3.5	0.6	2.0	0.9	3.2	1.0	3.5	0.3	1.1
Oct	3.1	1.0	3.1	0.5	1.6	1.0	3.1	0.6	1.7	0.8	2.5	1.0	3.1	0.1	0.3
Nov	2.0	0.0	0.0	0.5	1.0	0.0	0.0	0.6	1.1	0.0	0.0	1.0	2.0	0.0	0.0
Dec	1.7	0.0	0.0	0.5	0.9	0.0	0.0	0.6	1.0	0.0	0.0	1.0	1.7	0.0	0.0
Total (in)	38.2		29.4		19.1		30.5		21.4		26.0		14.6		11.9
Total (ft)	3.2		2.4		1.6		2.5		1.8		2.2		1.2		1.0

Table f6. Crop evapotranspiration (ETc) for various crop groups for Taft weather subset.

	ETo	Alfalfa		Nursery		Pasture		Citrus		Deciduous		Vegetable		Vineyard	
		Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc	ETc
Jan	1.3	0.0	0.0	0.5	0.7	0.0	0.0	0.6	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Feb	1.8	0.0	0.0	0.5	0.9	0.0	0.0	0.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar	3.1	0.9	2.8	0.5	1.6	1.0	3.1	0.6	1.7	0.6	1.9	0.0	0.0	0.0	0.0
Apr	4.3	0.9	3.9	0.5	2.2	1.0	4.3	0.6	2.4	0.7	3.0	0.0	0.0	0.0	0.0
May	6.2	0.9	5.6	0.5	3.1	1.0	6.2	0.6	3.5	0.8	5.0	0.0	0.0	0.6	3.7
Jun	7.3	0.9	6.6	0.5	3.7	1.0	7.3	0.6	4.1	0.9	6.6	0.0	0.0	0.7	5.1
Jul	8.5	1.0	8.5	0.5	4.3	1.0	8.5	0.6	4.8	1.0	8.5	0.0	0.0	0.6	5.1
Aug	7.3	1.0	7.3	0.5	3.7	1.0	7.3	0.6	4.1	1.0	7.3	1.0	7.3	0.5	3.7
Sept	5.4	1.1	5.9	0.5	2.7	1.0	5.4	0.6	3.0	0.9	4.9	1.0	5.4	0.3	1.6
Oct	3.4	1.0	3.4	0.5	1.7	1.0	3.4	0.6	1.9	0.8	2.7	1.0	3.4	0.1	0.3
Nov	1.7	0.0	0.0	0.5	0.9	0.0	0.0	0.6	1.0	0.0	0.0	1.0	1.7	0.0	0.0
Dec	1.0	0.0	0.0	0.5	0.5	0.0	0.0	0.6	0.6	0.0	0.0	1.0	1.0	0.0	0.0
Total (in)	51.2		44.0		25.7		45.5		28.7		39.8		18.8		19.5
Total (ft)	4.3		3.7		2.1		3.8		2.4		3.3		1.6		1.6

APPENDIX C CURRENT GROSS IRRIGATION WATER REQUIREMENT

Table C1. Gross irrigation water requirement for alfalfa.

Table C2. Gross irrigation water requirement for nursery.

Table C3. Gross irrigation water requirement for pasture.

Table C4. Gross irrigation water requirement for citrus.

Table C5. Gross irrigation water requirement for deciduous.

Table C6. Gross irrigation water requirement for vegetable.

Table C7. Gross irrigation water requirement for vineyard.

Current Gross Irrigation Water Requirement

Alfalfa

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST	AW (ft)			Acres (ac)	AW (af)		
		Low	High		0	High		0	Low	High		Avg	Low	High
1 North Coast	2.4	0.8	1.2	0	60	70	0	1.9	2.8	2.3	0	0	0	0
2 Cayucos	2.4	0.8	1.2	0	60	70	0	1.9	2.8	2.3	0	0	0	0
3 Morro Bay	2.6	0.7	1.1	0	60	70	0	2.1	3.1	2.6	0	0	0	0
4 SLO/Avila	2.8	0.7	1.1	0	60	70	0	2.5	3.5	3.0	0	0	0	0
5 Five Cities	2.5	0.5	0.8	0	60	70	0	2.5	3.3	2.9	0	0	0	0
6 Nipomo Mesa	2.5	0.5	0.8	0	60	70	0	2.5	3.3	2.9	0	0	0	0
7 Cuyama	3.7	0.4	0.5	0	60	70	0	4.5	5.5	5.0	600	2,689	3,312	3,001
8 California Valley	3.7	0.4	0.5	0	60	70	0	4.5	5.5	5.0	0	0	0	0
9a Salinas	3.4	0.8	1.2	0	60	70	0	3.2	4.4	3.8	1,500	4,789	6,550	5,670
9b Creston	3.4	0.8	1.2	0	60	70	0	3.2	4.4	3.8	500	1,596	2,183	1,890
9c Shandon	3.4	0.4	0.5	0	60	70	0	4.1	5.1	4.6	1,000	4,092	5,066	4,579
10 Nacimiento	3.4	0.5	0.7	0	60	70	0	3.8	4.8	4.3	0	0	0	0

Nursery

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST	AW (ft)			Acres (ac)	AW (af)		
		Low	High		0	High		0	Low	High		Avg	Low	High
1 North Coast	1.6	0.6	1.0	0	60	70	0	0.9	1.7	1.3	0	0	0	0
2 Cayucos	1.6	0.6	1.0	0	60	70	0	0.9	1.7	1.3	0	0	0	0
3 Morro Bay	1.7	0.5	0.9	0	60	70	0	1.1	1.9	1.5	50	54	93	73
4 SLO/Avila	1.8	0.5	0.9	0	60	70	0	1.3	2.1	1.7	0	0	0	0
5 Five Cities	1.7	0.4	0.7	0	60	70	0	1.4	2.1	1.7	30	42	63	52
6 Nipomo Mesa	1.7	0.4	0.7	0	60	70	0	1.4	2.1	1.7	950	1,334	1,989	1,662
7 Cuyama	2.1	0.3	0.4	0	60	70	0	2.4	3.1	2.8	0	0	0	0
8 California Valley	2.1	0.3	0.4	0	60	70	0	2.4	3.1	2.8	0	0	0	0
9a Salinas	2.1	0.6	1.0	0	60	70	0	1.6	2.5	2.0	0	0	0	0
9b Creston	2.1	0.6	1.0	0	60	70	0	1.6	2.5	2.0	0	0	0	0
9c Shandon	2.1	0.3	0.4	0	60	70	0	2.3	3.0	2.6	0	0	0	0
10 Nacimiento	2.1	0.4	0.6	0	60	70	0	2.1	2.8	2.4	0	0	0	0

Pasture

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST	AW (ft)			Acres (ac)	AW (af)		
		Low	High		0	High		0	Low	High		Avg		
1 North Coast	2.5	0.8	1.2	0	60	70	0	2.0	3.0	2.5	0	0	0	0

2 Cayucos	2.5	0.8	1.2	0	60	70	0	2.0	3.0	2.5	0	0	0	0
3 Morro Bay	2.7	0.7	1.1	0	60	70	0	2.2	3.2	2.7	0	0	0	0
4 SLO/Avila	3.0	0.7	1.1	0	60	70	0	2.7	3.7	3.2	200	532	743	638
5 Five Cities	2.6	0.5	0.8	0	60	70	0	2.6	3.5	3.0	600	1,561	2,095	1,828
6 Nipomo Mesa	2.6	0.5	0.8	0	60	70	0	2.6	3.5	3.0	0	0	0	0
7 Cuyama	3.8	0.4	0.5	0	60	70	0	4.7	5.7	5.2	0	0	0	0
8 California Valley	3.8	0.4	0.5	0	60	70	0	4.7	5.7	5.2	0	0	0	0
9a Salinas	3.5	0.8	1.2	0	60	70	0	3.4	4.6	4.0	4,400	14,792	20,081	17,437
9b Creston	3.5	0.8	1.2	0	60	70	0	3.4	4.6	4.0	0	0	0	0
9c Shandon	3.5	0.4	0.5	0	60	70	0	4.3	5.3	4.8	0	0	0	0
10 Nacimiento	3.5	0.5	0.7	0	60	70	0	4.0	5.0	4.5	0	0	0	0

Permanent-Citrus

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST	AW (ft)			Acres (ac)	AW (af)		
		Low	High		0	Low		High	Avg	Low		High	Avg	
1 North Coast	1.8	0.8	1.2	0	60	70	0	0.9	1.7	1.3	50	45	85	65
2 Cayucos	1.8	0.8	1.2	0	60	70	0	0.9	1.7	1.3	200	181	339	260
3 Morro Bay	1.9	0.7	1.1	0	60	70	0	1.1	1.9	1.5	450	493	849	671
4 SLO/Avila	2.0	0.7	1.1	0	60	70	0	1.4	2.2	1.8	250	339	548	443
5 Five Cities	1.9	0.5	0.8	0	60	70	0	1.5	2.2	1.8	0	0	0	0
6 Nipomo Mesa	1.9	0.5	0.8	0	60	70	0	1.5	2.2	1.8	800	1,196	1,760	1,478
7 Cuyama	2.4	0.4	0.5	0.15	60	70	0	3.1	4.0	3.6	0	0	0	0
8 California Valley	2.4	0.4	0.5	0	60	70	0	2.7	3.4	3.0	0	0	0	0
9a Salinas	2.3	0.8	1.2	0	60	70	0	1.6	2.5	2.1	0	0	0	0
9b Creston	2.3	0.8	1.2	0	60	70	0	1.6	2.5	2.1	0	0	0	0
9c Shandon	2.3	0.4	0.5	0	60	70	0	2.5	3.2	2.9	0	0	0	0
10 Nacimiento	2.3	0.5	0.7	0	60	70	0	2.2	3.0	2.6	0	0	0	0

Permanent-Deciduous

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST	AW (ft)			Acres (ac)	AW (af)		
		Low	High		0	Low		High	Avg	Low		High	Avg	
1 North Coast	2.2	0.8	1.2	0	60	70	0	1.5	2.3	1.9	0	0	0	0
2 Cayucos	2.2	0.8	1.2	0	60	70	0	1.5	2.3	1.9	0	0	0	0
3 Morro Bay	2.3	0.7	1.1	0	60	70	0	1.7	2.6	2.1	0	0	0	0
4 SLO/Avila	2.5	0.7	1.1	0	60	70	0	2.0	3.0	2.5	250	512	749	631
5 Five Cities	2.2	0.5	0.8	0	60	70	0.8	2.8	3.6	3.2	600	1,702	2,179	1,940
6 Nipomo Mesa	2.2	0.5	0.8	0	60	70	0	2.0	2.8	2.4	0	0	0	0
7 Cuyama	3.3	0.4	0.5	0.15	60	70	0	4.7	5.8	5.3	2,200	10,314	12,789	11,551
8 California Valley	3.3	0.4	0.5	0	60	70	0	4.0	4.9	4.5	0	0	0	0

9a Salinas	3.0	0.8	1.2	0	60	70	0	2.7	3.8	3.2	200	540	759	649
9b Creston	3.0	0.8	1.2	0	60	70	0	2.7	3.8	3.2	200	540	759	649
9c Shandon	3.0	0.4	0.5	0	60	70	0	3.6	4.5	4.0	200	720	899	809
10 Nacimiento	3.0	0.5	0.7	0	60	70	0	3.3	4.3	3.8	0	0	0	0

Vegetable

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST	AW (ft)			Acres (ac)	AW (af)		
		Low	High		0	Low		High	Avg	Low		High	Avg	
1 North Coast	1.2	0.3	0.5	0	65	75	0	1.0	1.4	1.2	300	295	429	362
2 Cayucos	1.2	0.3	0.5	0	65	75	0	1.0	1.4	1.2	400	393	572	483
3 Morro Bay	1.3	0.3	0.5	0	65	75	0	1.1	1.6	1.4	4,500	5,113	7,163	6,138
4 SLO/Avila	1.5	0.3	0.5	0	65	75	0	1.3	1.8	1.6	1,500	2,004	2,734	2,369
5 Five Cities	1.3	0.2	0.3	0	65	75	0	1.3	1.7	1.5	8,000	10,131	13,373	11,752
6 Nipomo Mesa	1.3	0.2	0.3	0	65	75	0	1.3	1.7	1.5	17,000	21,529	28,417	24,973
7 Cuyama	1.6	0.1	0.2	0	65	75	0	1.8	2.2	2.0	2,000	3,594	4,416	4,005
8 California Valley	1.6	0.1	0.2	0	65	75	0	1.8	2.2	2.0	100	180	221	200
9a Salinas	1.6	0.3	0.5	0	65	75	0	1.5	2.0	1.7	200	294	398	346
9b Creston	1.6	0.3	0.5	0	65	75	0	1.5	2.0	1.7	0	0	0	0
9c Shandon	1.6	0.1	0.2	0	65	75	0	1.8	2.2	2.0	600	1,092	1,340	1,216
10 Nacimiento	1.6	0.2	0.3	0	65	75	0	1.7	2.2	1.9	0	0	0	0

Vineyard

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST	AW (ft)			Acres (ac)	AW (af)		
		Low	High		0	Low		High	Avg	Low		High	Avg	
1 North Coast	1.0	0.6	1.0	0	65	75	0.5	0.5	1.1	0.8	0	0	0	0
2 Cayucos	1.0	0.6	1.0	0	65	75	0.5	0.5	1.1	0.8	0	0	0	0
3 Morro Bay	1.0	0.5	0.9	0	65	75	0.5	0.6	1.2	0.9	0	0	0	0
4 SLO/Avila	1.2	0.5	0.9	0	65	75	0.5	0.8	1.4	1.1	1,350	1,107	1,932	1,519
5 Five Cities	1.0	0.4	0.7	0	65	75	0.5	0.9	1.4	1.2	700	657	999	828
6 Nipomo Mesa	1.0	0.4	0.7	0	65	75	0.5	0.9	1.4	1.2	400	375	571	473
7 Cuyama	1.6	0.3	0.4	0	65	75	0.5	2.1	2.6	2.3	0	0	0	0
8 California Valley	1.6	0.3	0.4	0	65	75	0.5	2.1	2.6	2.3	0	0	0	0
9a Salinas	1.4	0.6	1.0	0	65	75	0.5	1.1	1.8	1.5	2,500	2,858	4,587	3,722
9b Creston	1.4	0.6	1.0	0	65	75	0.5	1.1	1.8	1.5	1,500	1,715	2,752	2,233
9c Shandon	1.4	0.3	0.4	0	65	75	0.5	1.8	2.3	2.1	7,000	12,899	16,232	14,566
10 Nacimiento	1.4	0.4	0.6	0	65	75	0.5	1.6	2.2	1.9	0	0	0	0

APPENDIX D PROJECTED GROSS IRRIGATION WATER REQUIREMENT

Table d1. Gross irrigation water requirement for alfalfa.

Table d2. Gross irrigation water requirement for nursery.

Table d3. Gross irrigation water requirement for pasture.

Table d4. Gross irrigation water requirement for citrus.

Table d5. Gross irrigation water requirement for deciduous.

Table d6. Gross irrigation water requirement for vegetable.

Table d7. Gross irrigation water requirement for vineyard.

Projected Irrigation Water Requirements

Alfalfa

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST	AW (ft)			Acres (ac)	AW (af)		
		Low	High		Low	High		Low	High	Avg		Low	High	Avg
1 North Coast	2.4	0.8	1.2	0	60	70	0	1.9	2.8	2.3	0	0	0	0
2 Cayucos	2.4	0.8	1.2	0	60	70	0	1.9	2.8	2.3	0	0	0	0
3 Morro Bay	2.6	0.7	1.1	0	60	70	0	2.1	3.1	2.6	0	0	0	0
4 SLO/Avila	2.8	0.7	1.1	0	60	70	0	2.5	3.5	3.0	0	0	0	0
5 Five Cities	2.5	0.5	0.8	0	60	70	0	2.5	3.3	2.9	0	0	0	0
6 Nipomo Mesa	2.5	0.5	0.8	0	60	70	0	2.5	3.3	2.9	0	0	0	0
7 Cuyama	3.7	0.4	0.5	0	60	70	0	4.5	5.5	5.0	600	2,689	3,312	3,001
8 California Valley	3.7	0.4	0.5	0	60	70	0	4.5	5.5	5.0	0	0	0	0
9a Salinas	3.4	0.8	1.2	0	60	70	0	3.2	4.4	3.8	1,300	4,151	5,677	4,914
9b Creston	3.4	0.8	1.2	0	60	70	0	3.2	4.4	3.8	400	1,277	1,747	1,512
9c Shandon	3.4	0.4	0.5	0	60	70	0	4.1	5.1	4.6	800	3,274	4,053	3,663
10 Nacimiento	3.4	0.5	0.7	0	60	70	0	3.8	4.8	4.3	0	0	0	0

Nursery

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST	AW (ft)			Acres (ac)	AW (af)		
		0.0 Low	High		Low	High		Low	High	Avg		Low	High	Avg
1 North Coast	1.6	0.6	1.0	0	60	70	0	0.9	1.7	1.3	0	0	0	0
2 Cayucos	1.6	0.6	1.0	0	60	70	0	0.9	1.7	1.3	0	0	0	0
3 Morro Bay	1.7	0.5	0.9	0	60	70	0	1.1	1.9	1.5	60	64	112	88
4 SLO/Avila	1.8	0.5	0.9	0	60	70	0	1.3	2.1	1.7	0	0	0	0
5 Five Cities	1.7	0.4	0.7	0	60	70	0	1.4	2.1	1.7	50	70	105	87
6 Nipomo Mesa	1.7	0.4	0.7	0	60	70	0	1.4	2.1	1.7	1,350	1,896	2,827	2,361
7 Cuyama	2.1	0.3	0.4	0	60	70	0	2.4	3.1	2.8	0	0	0	0
8 California Valley	2.1	0.3	0.4	0	60	70	0	2.4	3.1	2.8	0	0	0	0
9a Salinas	2.1	0.6	1.0	0	60	70	0	1.6	2.5	2.0	0	0	0	0
9b Creston	2.1	0.6	1.0	0	60	70	0	1.6	2.5	2.0	0	0	0	0
9c Shandon	2.1	0.3	0.4	0	60	70	0	2.3	3.0	2.6	0	0	0	0
10 Nacimiento	2.1	0.4	0.6	0	60	70	0	2.1	2.8	2.4	0	0	0	0

Pasture

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST	AW (ft)			Acres (ac)	AW (af)		
		Low	High		Low	High		Low	High	Avg		Low	High	Avg
1 North Coast	2.5	0.8	1.2	0	60	70	0	2.0	3.0	2.5	0	0	0	0

2 Cayucos	2.5	0.8	1.2	0	60	70	0	2.0	3.0	2.5	0	0	0	0
3 Morro Bay	2.7	0.7	1.1	0	60	70	0	2.2	3.2	2.7	0	0	0	0
4 SLO/Avila	3.0	0.7	1.1	0	60	70	0	2.7	3.7	3.2	200	532	743	638
5 Five Cities	2.6	0.5	0.8	0	60	70	0	2.6	3.5	3.0	500	1,301	1,746	1,523
6 Nipomo Mesa	2.6	0.5	0.8	0	60	70	0	2.6	3.5	3.0	0	0	0	0
7 Cuyama	3.8	0.4	0.5	0	60	70	0	4.7	5.7	5.2	0	0	0	0
8 California Valley	3.8	0.4	0.5	0	60	70	0	4.7	5.7	5.2	0	0	0	0
9a Salinas	3.5	0.8	1.2	0	60	70	0	3.4	4.6	4.0	4,200	14,120	19,168	16,644
9b Creston	3.5	0.8	1.2	0	60	70	0	3.4	4.6	4.0	0	0	0	0
9c Shandon	3.5	0.4	0.5	0	60	70	0	4.3	5.3	4.8	0	0	0	0
10 Nacimiento	3.5	0.5	0.7	0	60	70	0	4.0	5.0	4.5	0	0	0	0

Permanent-Citrus

WPA	ET (FT)	EFF PREC (FT)		LR	IE	FROST	AW (ft)			Acres (ac)	AW (af)			
		Low	High				Low	High	Avg		Low	High	Avg	
1 North Coast	1.8	0.8	1.2	0	70	80	0	0.8	1.5	1.1	50	40	73	56
2 Cayucos	1.8	0.8	1.2	0	70	80	0	0.8	1.5	1.1	200	158	290	224
3 Morro Bay	1.9	0.7	1.1	0	70	80	0	1.0	1.6	1.3	450	431	728	580
4 SLO/Avila	2.0	0.7	1.1	0	70	80	0	1.2	1.9	1.5	350	415	657	536
5 Five Cities	1.9	0.5	0.8	0	70	80	0	1.3	1.9	1.6	0	0	0	0
6 Nipomo Mesa	1.9	0.5	0.8	0	70	80	0	1.3	1.9	1.6	900	1,177	1,697	1,437
7 Cuyama	2.4	0.4	0.5	0.15	70	80	0	2.7	3.4	3.1	0	0	0	0
8 California Valley	2.4	0.4	0.5	0	70	80	0	2.3	2.9	2.6	0	0	0	0
9a Salinas	2.3	0.8	1.2	0	70	80	0	1.4	2.2	1.8	0	0	0	0
9b Creston	2.3	0.8	1.2	0	70	80	0	1.4	2.2	1.8	0	0	0	0
9c Shandon	2.3	0.4	0.5	0	70	80	0	2.2	2.8	2.5	0	0	0	0
10 Nacimiento	2.3	0.5	0.7	0	70	80	0	2.0	2.6	2.3	0	0	0	0

Permanent-Deciduous

WPA	ET (FT)	EFF PREC (FT)		LR	IE	FROST	AW (ft)			Acres (ac)	AW (af)			
		Low	High				Low	High	Avg		Low	High	Avg	
1 North Coast	2.2	0.8	1.2	0	70	80	0	1.3	2.0	1.6	0	0	0	0
2 Cayucos	2.2	0.8	1.2	0	70	80	0	1.3	2.0	1.6	0	0	0	0
3 Morro Bay	2.3	0.7	1.1	0	70	80	0	1.5	2.2	1.8	0	0	0	0
4 SLO/Avila	2.5	0.7	1.1	0	70	80	0	1.8	2.6	2.2	300	538	771	654
5 Five Cities	2.2	0.5	0.8	0	70	80	0.8	2.6	3.2	2.9	650	1,678	2,097	1,888
6 Nipomo Mesa	2.2	0.5	0.8	0	70	80	0	1.8	2.4	2.1	0	0	0	0
7 Cuyama	3.3	0.4	0.5	0.15	70	80	0	4.1	5.0	4.5	2,500	10,256	12,457	11,356

8 California Valley	3.3	0.4	0.5	0	70	80	0	3.5	4.2	3.9	0	0	0	0
9a Salinas	3.0	0.8	1.2	0	70	80	0	2.4	3.3	2.8	300	709	975	842
9b Creston	3.0	0.8	1.2	0	70	80	0	2.4	3.3	2.8	300	709	975	842
9c Shandon	3.0	0.4	0.5	0	70	80	0	3.2	3.9	3.5	300	945	1,155	1,050
10 Nacimiento	3.0	0.5	0.7	0	70	80	0	2.9	3.7	3.3	0	0	0	0

Vegetable

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST			AW (ft) Avg	Acres (ac)	AW (af)		
		Low	High		0	Low	High	Low	High			Avg	Low	High
1 North Coast	1.2	0.3	0.5	0	70	80	0	0.9	1.3	1.1	350	323	465	394
2 Cayucos	1.2	0.3	0.5	0	70	80	0	0.9	1.3	1.1	400	369	531	450
3 Morro Bay	1.3	0.3	0.5	0	70	80	0	1.1	1.5	1.3	4,500	4,793	6,651	5,722
4 SLO/Avila	1.5	0.3	0.5	0	70	80	0	1.3	1.7	1.5	1,300	1,628	2,200	1,914
5 Five Cities	1.3	0.2	0.3	0	70	80	0	1.2	1.6	1.4	8,300	9,854	12,883	11,369
6 Nipomo Mesa	1.3	0.2	0.3	0	70	80	0	1.2	1.6	1.4	17,200	20,421	26,698	23,559
7 Cuyama	1.6	0.1	0.2	0	70	80	0	1.7	2.1	1.9	2,300	3,875	4,716	4,295
8 California Valley	1.6	0.1	0.2	0	70	80	0	1.7	2.1	1.9	100	168	205	187
9a Salinas	1.6	0.3	0.5	0	70	80	0	1.4	1.8	1.6	200	276	370	323
9b Creston	1.6	0.3	0.5	0	70	80	0	1.4	1.8	1.6	0	0	0	0
9c Shandon	1.6	0.1	0.2	0	70	80	0	1.7	2.1	1.9	600	1,023	1,245	1,134
10 Nacimiento	1.6	0.2	0.3	0	70	80	0	1.6	2.0	1.8	0	0	0	0

Vineyard

WPA	ET (FT)	EFF PREC (FT)		LR	IE		FROST			AW (ft) Avg	Acres (ac)	AW (af)		
		0.0 Low	High		0	Low	High	Low	High			Avg		
1 North Coast	1.0	0.6	1.0	0	70	80	0.5	0.5	1.1	0.8	0	0	0	0
2 Cayucos	1.0	0.6	1.0	0	70	80	0.5	0.5	1.1	0.8	0	0	0	0
3 Morro Bay	1.0	0.5	0.9	0	70	80	0.5	0.6	1.2	0.9	0	0	0	0
4 SLO/Avila	1.2	0.5	0.9	0	70	80	0.5	0.8	1.4	1.1	1,800	1,440	2,456	1,948
5 Five Cities	1.0	0.4	0.7	0	70	80	0.5	0.9	1.4	1.1	1,100	1,002	1,496	1,249
6 Nipomo Mesa	1.0	0.4	0.7	0	70	80	0.5	0.9	1.4	1.1	400	364	544	454
7 Cuyama	1.6	0.3	0.4	0	70	80	0.5	2.0	2.5	2.2	0	0	0	0
8 California Valley	1.6	0.3	0.4	0	70	80	0.5	2.0	2.5	2.2	0	0	0	0
9a Salinas	1.4	0.6	1.0	0	70	80	0.5	1.1	1.7	1.4	3,800	4,192	6,609	5,401
9b Creston	1.4	0.6	1.0	0	70	80	0.5	1.1	1.7	1.4	2,300	2,537	4,000	3,269
9c Shandon	1.4	0.3	0.4	0	70	80	0.5	1.8	2.2	2.0	10,000	17,589	21,889	19,739
10 Nacimiento	1.4	0.4	0.6	0	70	80	0.5	1.5	2.0	1.8	0	0	0	0

REFERENCES

References (Definitions):

Burt, C.M. 1997. Irrigation Water Management. Agricultural Engineering Department, Cal Poly San Luis Obispo.

CDWR. 1994. California Water Plan Update. Department of Water Resources.

CFA. 1995. Western Fertilizer Handbook, 8th ed.,. California Fertilizer Association.

References (Text):

Bianchi, Mary. 1998. Personal Communication. UC Farm Advisor.

Burt, Charles. 1998. Personal Communication. Director, Irrigation Training and Research Center.

Burt, C.M. 1997. Irrigation Water Management. Agricultural Engineering Department, Cal Poly San Luis Obispo.

Burt, C.M., A.J. Clemmens, T.S. Strelkoff, K.H. Solomon, R.D. Bliesner, L.A. Hardy, T.A. Howell, D.E. Eisenhauer. "Irrigation Performance Measures: Efficiency and Uniformity". Journal of Irrigation and Drainage Engineering. November/December 1997. pp. 423-442.

CDWR. 1974. Vegetative Water Use in California. Bulletin 113-3. California Department of Water Resources.

CDWR. 1986. San Luis Obispo County Master Water Plan Update. California Department of Water Resources.

CDWR. 1989. Effective Precipitation-A Field Study to Assess Consumptive Use of Winter Rains by Spring and Summer Crops. California Department of Water Resources.

CFA. 1995. Western Fertilizer Handbook, 8th ed.,. California Fertilizer Association.

Chipping, D., Lang, R. Eatough, N. Long. Dianne, Nalluri, A. 1993. A Study of the Paso Robles Ground Water Basin to Establish Best Management Practices and Establish Salt Objectives. Coastal Resources Institute.

Fastenau, R. 1998. Personal Communication. Irrigation Specialist. Cachuma Resource Conservation District.

Hoffman, G.J., J.D. Rhoades, J. Letey, F. Sheng. 1990. "Salinity Management." In Management of Farm Irrigation Systems. ASAE Monograph Number 9. Edited by Hoffman, Howell, Solomon.

Lacmmlen, Frank. 1998. Personal Communication. UC Farm Advisor.

Martin, D.L., Stegman, E.D., Fereres, E. 1990. "Irrigation Scheduling Principles." In Management of Farm Irrigation Systems. ASAE Monograph Number 9. Edited by Hoffman, Howell, Solomon.

Smith, Mike. 1997. Personal Communication. UC Farm Advisor.

Snyder, R.L. and K.F. Schulbach. 1992. . Central Coast Crop Coefficients for Field and Vegetable Crops. Drought Tip Number 92-45. California Department of Water Resources and University of California.

Snyder, R.L., B.J. Lanini, D.A. Shaw, W.O. Pruitt. 1989. Using Reference Evapotranspiration (ET_o) and Crop Coefficients to Estimate Crop Evapotranspiration (ET_c) for Trees and Vines. UC Cooperative Extension Leaflet 21428.

Snyder, R.L. W.O. Pruitt, D.A. Shaw. 1987. Determining Daily Reference Evapotranspiration (ET_o), UC Cooperative Extension Leaflet 21426.

San Luis Obispo County Agricultural Commissioner's Annual Crop Reports, 1991 - 1996.

_____ 1991. Irrigation Water Use for Major Crops Grown in Santa Barbara County. UC Cooperative Extension.